DOCUMENT RESUME

ED 151 733 CS 003 960

AUTHOR Ehri, Linnea C.; And Others
TITLE The Recognition of Words.
INSTITUTION International Reading Association, Newark, Del.
PUB DATE 78
NOTE 79p.
AVAILABLE FROM International Reading Association, 800 Barksdale Rd., Newark, Delaware 19711 (Order No. 523, $2.50 member, $3.50 non-member)

EDRS PRICE MF-$0.83 HC-$4.67 Plus Postage.
DESCRIPTORS *Beginning Reading; *Child Language; Phoneme Grapheme Correspondence; Phonetics; *Phonology; Primary Education; Psycholinguistics; *Reading Instruction; *Reading Research; Reading Skills; Semantics; *Word Recognition

ABSTRACT

The three articles in this publication discuss the following topics: (1) a psycholinguistic perspective on beginning reading that focuses on the child's linguistic system, rather than on the information processing strategies he or she learns to use in reading, and identifies word recognition as the major hurdle faced by the beginner; (2) the issue of whether the meaning of words can be assessed directly from their representation; and (3) the status of knowledge about phonological rules and their role in reading. Lists of references accompany each article. (CC)

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IRA series on the development of the reading process

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THE RECOGNITION OF WORDS

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Published by
INTERNATIONAL READING ASSOCIATION
800 Barksdale Road Newark, Delaware 19711

CS003960

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Library of Congress Cataloging in Publication Data

Ehri, Linnea C.
The recognition of words.
(IRA series on the development of the reading process) Includes bibliographies.
1. Word recognition. 2. Reading, Psychology of.
I. Barron, Roderick W., joint author. II. Feldman, Jeffrey M., joint author.
III. Murray, Frank B. IV. Title. V. Series: International Reading Association. IRA series on the development of the reading process.
LB1573.E425 372.4'01'9 77-17225
ISBN 0-87207-523-0

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Foreword

It is particularly fitting that the International Reading Association should publish this *Series on the Development of the Reading Process* for the volumes in this series exemplify the value of reading—the value of the printed word. The Series originated in a four-week summer institute at the University of Delaware. Those fortunate people who were able to participate in the institute counted it an enriching experience. How does one share such an experience at a reasonable cost with thousands of others who will wish they might have been present to participate? Through the medium of print. In this IRA series, participation in that unusual institute is available to all interested readers.

The volumes in this series represent more than just a series of papers presented at the institute. They incorporate ideas raised in the discussions at the institute and new developments interpreted through perspectives engendered by the institute.

This *Series on the Development of the Reading Process* deals with important basic issues that are fundamental to understanding the changing nature of the reading process as both the process and the child develop. In the literature on reading, these issues—such as the development of the child's cognitive abilities, the development of the child's semantic system, the child's changing conceptions of language, and the developing relation between listening and reading—are often referred to knowingly as if they are well understood or as if mere reference to them will prove a point. In this series, however, each volume deals with one such basic issue in a comprehensive way and specifically in relation to learning to read.

The person with the vision to develop the institute and with the wisdom and commitment to see that the fruits of the institute were made available to others is Frank B. Murray, editor of this series. The International Reading Association and all who value a deeper understanding of the development of the ability to read are indebted to him for his vision and his labor.

WALTER H. MACGINITIE

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The International Reading Association attempts, through its publications, to provide a forum for a wide spectrum of opinion on reading. This policy permits divergent viewpoints without assuming the endorsement of the Association.

Preface

During the summer of 1974, the Society for Research in Child Development with the support of the Grant Foundation of New York sponsored a four week interdisciplinary institute at the University of Delaware on Reading and Child Development. The thirty-three institute faculty were researchers in the disciplines of psychology, psychiatry, education, linguistics, neurology, sociology, and the law. Each spent from three to five days at the institute formally and informallly presenting the applications of their research to the field of reading.

The institute participants were advanced doctoral students and postdoctoral faculty from various disciplines who had an interest in and commitment to research in reading. They were present for the full four weeks, and some of them are contributing authors to this IRA series on *The Development of the Reading Process*. Each title in the series is based upon aspects of the institute proceedings, intensive discussions between the participants and the faculty, and each author's particular perspective.

The series is organized around the notion that the child's reading behavior, among other things, is a developmental phenomenon. This means that, like other developmental phenomena, there are certain necessary and sufficient conditions for it and that it changes both quantitatively (e.g., it becomes faster and more efficient) and qualitatively (e.g., different and more complex models are needed to explain it) as the child ages. The series will examine the development of reading from the perspective of the perceptual, cognitive, neurological, and linguistic prerequisites for it, specific factors in its acquisition, and factors which lead to the enhancement of the reading skill once it has been acquired.

While many have claimed that reading is more than the mere recognition of words virtually no one has claimed that it was less than that. In *The Recognition of Words*, Linnea Ehri proposes a general model for the recognition of words which requires that various aspects of words—namely their phonetic, morphological, semantic, syntactic, and orthographic charac-

teristics—must be amalgamated and assimilated into the child's previously constructed linguistic systems. She analyzes the various contributions each aspect or component of a word makes to its recognition by the beginning reader and makes a case for the psychological reality of each aspect.

Both Barron and Feldman examine one feature of Ehri's model in more detail. Since language may be represented in both speech and print, and since words have both phonetic and orthographic properties, the issue of the relation of these properties in initial reading is a continuing pedagogical question. Barron argues that the meaning of words can be assessed directly from the graphic representation without the need for an intervening phonetic or sound representation. Feldman, on the other hand, outlines the status of our knowledge about phonological rules and speculates about their role in reading. Since a number of reading pedagogies are based upon assumption of the relationship between orthographic and phonological properties, an examination of the empirical data and theoretical issues in this area of word recognition psychology is at least timely.

The success of the institute, upon which this series is based, was due to the energies and talents of many people. In addition to the dedication of the participants, faculty, and administrative staff, whose names appear elsewhere in this issue, the staff of Clayton Hall and the Department of Educational Foundations of the University of Delaware and the members of the Long Range Planning Committee of the Society for Research in Child Development contributed substantially to the planning and execution of the institute. Finally, the series itself was greatly improved by the editorial assistance of Lloyd Kline and Faye Branca of the International Reading Association.

Frank B. Murray

Beginning Reading from a Psycholinguistic Perspective: Amalgamation of Word Identities[1]

Linnea C. Ehri
University of California at Davis

In order to understand how children learn to read, it is essential to consider this process from a psycholinguistic perspective. A number of psycholinguists have given some attention to reading as a language process (Goodman, 1968, 1969, 1970, 1972; Smith, 1971, 1973; C. Chomsky, 1972; Gleitman and Rozin, 1973; papers in Kavanaugh and Mattingly, 1972; Ryan and Semmel, 1969). Goodman has provided the most elaborate description. He portrays reading as a psycholinguistic guessing game in which the reader processes and coordinates simultaneously three types of information—graphic, syntactic, and semantic. Prior to encountering the printed stimulus at any point in a text, the reader holds syntactic and semantic expectations about the information residing there. Upon arrival, he samples the graphic cues in accordance with his expectations and uses this information to generate a guess about the message. If the guess proves consistent with subsequent information, then it is accepted.If not, the reader recognizes that he has misread the stimulus and he reinspects it to correct his error. The proficient reader is thought to ignore many of the features contained in the graphic display. Goodman, in fact, asserts that the more efficient the reader, the fewer printed cues he needs to derive meaning accurately from text. Furthermore, this text sampling process is governed primarily by the adequacy of the meaning being extracted. If the reader misreads a word but produces a semantically acceptable substitute, he fails to recognize the discrepancy. However, if his construction does not make sense, the inaccuracy is detected.

[1] The author thanks Ellen Ryan and Kenneth Goodman for their extensive comments and criticisms of this chapter.

Although Goodman provides a detailed description of skillful reading, he fails to explain how a reader achieves this text sampling capability. He has entertained some hypotheses about reading acquisition (Goodman, 1968) but has subsequently rejected these as inadequate. The present chapter is intended to open up some questions, to raise some issues, and to propose some hypotheses about theory and research on beginning reading from a psycholinguistic perspective. The approach taken here differs from Goodman's in that it focuses upon the child's linguistic system rather than upon information processing strategies he learns to use in his reading, and it identifies word recognition as the major hurdle faced by the beginner.

In this chapter the problems regarded as central to acquiring reading proficiency concern printed language, what the child knows about spoken language when he encounters print, how he learns to fit printed language into his existing linguistic system to derive meaning when he reads, what cognitive-linguistic structures are formed as a consequence of his interaction with printed language, and how these might enable him to read very rapidly without reliance upon speech. Before tackling uncertainties about reading acquisition, the chapter will review the structure of both printed and spoken language and consider how these are related and what this relationship means for the reading process. Then it will identify some theoretical underpinnings regarded as central to a study of reading acquisition. Finally, it will focus upon beginning reading and a discussion of three aspects of the process: becoming aware of words as units of language, recognizing the identities of printed words, and synthesizing printed words into sentences.

Printed and Spoken Language Systems

In order to account for the relationship between sounds in speech and underlyng meanings, N. Chomsky (1957, 1965, 1967) has proposed a model of linguistic competence. This model consists of three systems of rules referred to as the phonological, the syntactic, and the semantic components. In addition, there is a lexicon which contains the stock of abstract lexical units or words which make up the language. Associated

with each word in the lexicon is information about its sound, meaning, and syntactic function. The three components of the linguistic system are employed for processing sequences of words. The phonological system entails rules which specify the relationship between words and their realization as sounds in speech. The syntactic system is the device which organizes sequences of words and identifies structural relationships among the parts. It applies rules to identify how the words are grouped to form a hierarchy of phrases, where the major boundaries of these phrases lie, how phrases and their parts relate to one another, which parts of the sentence function as subject, object, etc. The semantic system consists of rules for interpreting the meanings of word sequences once they have been analyzed syntactically.

The entire system is thought to work as follows in deriving meaning from speech. Sounds enter the phonological component and are converted to a sequence of abstract lexical units. These units are then processed by the syntactic component. Once structural relations among the parts are identified, the semantic component takes over and assigns meanings to words and word combinations. Although this description portrays the process as a sequential one, this is not really the case. Rather the parts interact, with one part influencing the processing conducted by another. For example, the perception and interpretation of sounds entering the system are influenced by prior processing which sets up syntactic patterns and categories into which sounds must fit. In the middle of a sentence, the syntactic relations already aroused severely limit how subsequent sounds are perceived and organized into words.

In order for information to enter the linguistic system in the above model, it must be represented as speech sounds. The model was not designed to account for input from print, unless, in reading, print is transformed to speech before it enters the linguistic system. Since the necessity of this transformaton is questionable, it is important to consider alternative hypotheses about how printed language is processed, specifically, whether print may be sufficiently systematic to function as a representational system for language in its own right, as an alternative to spoken input, or whether information contained in print derives its regularity from its relation to speech and so must be

converted to a phonological form in order for the input to become interpretable by the system?

The most important evidence revealing that printed language is indeed systematic comes from its treatment of words. In print, each word is comprised of a sequence of letters and this spelling pattern recurs each time that word is represented. Thus, each word has its own characteristic graphic form and so can be identified visually each time it appears. Furthermore, words are arranged sequentially in rows from left to right, they are separated by blank spaces, and they are ordered to form larger phrase and sentence units bounded by punctuation marks. Thus, not only words but also sentences are represented systematically in print.

Printed English, employing alphabet notation, is constructed to map speech. A close match can be achieved if one operates at the word level. Much less systematic are the relationships between graphemes in print and phonemes in speech (Venezky, 1970). Though variable, the letter-sound correspondences within words are not arbitrary, and so a person can perform a match by attending to at least some of the printed letters and finding their correlates in speech. However, for many letters, in order to know what phonological values are to be assigned, one must know or be able to determine which word is being represented. Only after the word is identified does it become clear how the letters are translated into sounds.

Although print is related to speech, it can be shown that speech is not an essential component of the graphic representational system. In order for print to depend upon speech for its systematic nature, spelling patterns would have to be so unpredictable and changing that to figure out what word or sentence was being represented in print, one would need print-speech recoding rules to extract the underlying form.Or print would have to consist of a phonetic alphabet which mapped speech perfectly at the level of sounds so that the phonological component would be the most efficient way of converting these sounds into words. Clearly, neither of these is the case. Printed language has its own system for representing words and sentences, in terms of ordered clusters of printed letter configurations.

A comparison of graphic and phonological systems suggest that printed language may, in fact, be more dependable than speech as a mode of representing language. In contrast to

speech where words and even sentences are commonly run together, print very clearly marks the breaks between both words and sentences. Also, the lexical identities of words are more easily discerned in print than in speech. Whereas in print the same word always recurs with the same spelling pattern, in speech people speaking different dialects may pronounce the same words quite differently. In addition, unless it is dialogue or a contraction, print usually identifies all of the morphemes, whereas in speech these may be collaspsed (e.g., "What are you doing?" vs. "Whacha doin?").

These facts combine to suggest that print does involve a system for representing language, one which is related to but not dependent upon speech for its structure. In terms of the model of linguistic competence, this suggests that printed language be represented as a component operating not in a series with but rather in parallel to the phonological component. Just as the phonological component converts speech sounds into a sequence of abstract words, so the graphic component converts rows of printed letters, spaces, capital letters, and punctuation marks into abstract words. Output from either source is then fed directly to the syntactic component for further processing. A diagram of this model is portrayed in Figure 1. The component is referred to as graphic rather than orthographic for the reason that it consists of not only rules capturing word-spelling regularities but also rules involving punctuation and the location of word and sentence boundaries.

In addition to including a graphic component, the linguistic model needs to be altered in another way to account for competence with printed language. As is evident from the above description, words are fundamental constituents of the linguistic system. They are conceptualized as abstract units having several different facets or identities. At least six can be distinguished. Every word has an acoustic identity, the way the word sounds and is heard in speech. Every word has an articulatory identity, the way the speech musculature moves to pronounce the word. Except in cases where it is necessary to preserve this distinction, both of these identities will be referred to as the word's phonological identity. Every word has a morphological identity. This includes information about whether the word is made up of one morpheme or a combination of morphemes, each performing a separate syntactic or semantic

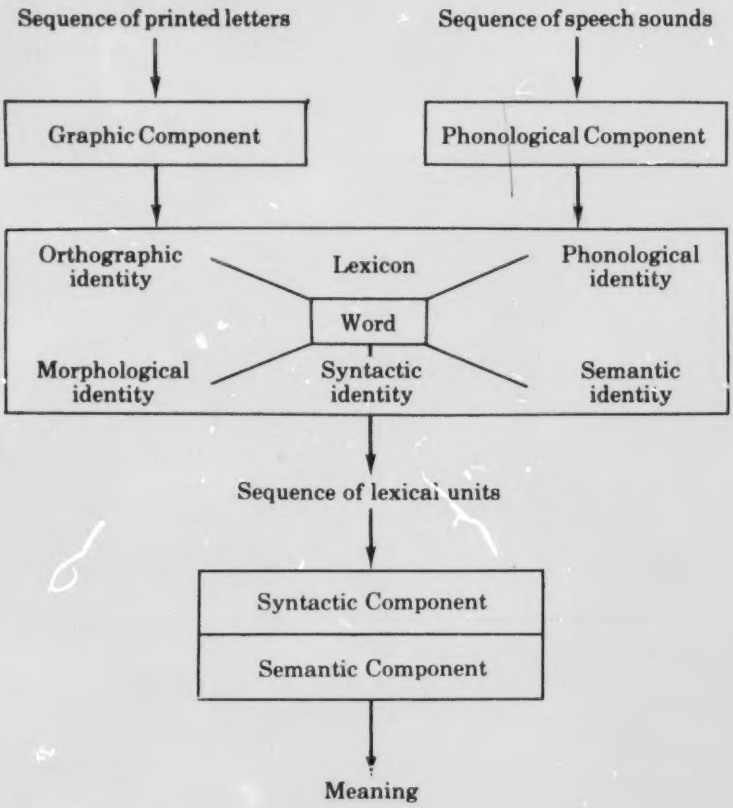

Figure 1. Model of Linguistic Competence

function (e.g., "un-happy" and "cook-ing" are words comprised of two morphemes). Most words have a semantic identity, that is, a "dictionary definition." And every word has a syntactic identity, which involves a specification of the grammatical function of the word in sentences (i.e., noun, verb, adjective, determiner). All of these identities are acquired as a consequence of achieving competence with spoken language, and they are lodged in the lexicon. In order for the linguistic model to account for competence with printed language, one other

identity, the word's orthographic form, needs to be added to information known about a word in the lexicon. All of these word identities are depicted in Figure 1. As will be discussed subsequently, one of the most important tasks facing the beginning reader is to amalgamate a word's other identities with its graphic form so that by simply glancing at this form, a reader can recognize all of the relevant aspects of the word.

Some Remarks on Theoretical Perspective

Before proceeding to a discussion of beginning reading, it is necessary to establish some bearings, that is, to make clear what sort of view will be taken of the reading process and what distinctions are seen as important. First an adaptation model of beginning reading is adopted, one which postulates the formation and subsequent alteration of cognitive-linguistic structures as a consequence of one's interaction with his environment. Second, two types of linguistic knowledge resulting from adaptation to printed language are distinguished, implicit knowledge, and metalinguistic awareness. Third, it is argued that reading is language reception, not language production.

Language learning in general is an adaptive process, responsive to the demands imposed by the environment and the success achieved in meeting these demands. It is a constructive process in that cognitive structures or rules are erected as a result of attempts to adapt. These rules represent efforts by the learner's information processing system to capture the regularities of prior experiences so as to improve subsequent adaptations. Growth in the system entails the successive restructuring of these existing rules as their strengths and limitations are discovered (see Part 2 of Rohwer, Ammon, and Cramer, 1974).

In a psycholinguistic theory of beginning reading, it is necessary to talk about the emergence of cognitive-linguistic structures in order to explain what happens as a child learns to read, specifically, as he learns to draw meaning from printed language. This is very different from an approach suggesting that the learner attends to and stores unique features of stimuli or experiences. Rather, the mind organizes experiences in terms of abstract rules which capture their regularities. This approach is also different from one which analyzes learning

into a sequence of component capabilities, each to be mastered before successive capabilities are learned (Gagne, 1970). The cognitive-linguistic perspective regards acquistion of capabilities as an integrated process happening concurrently, not successively. It is important for capabilities to grow and work together in order to effect optimal adaptations. Treating them separately may only produce narrow adaptations or possibly maladaptations which will need overhauling when the capabilities attempt to merge as part of the full system.

In a search for structures and rules which characterize a child's linguistic system, it is important to draw a distinction between implicit knowledge and metalinguistic awareness of those rules or structures. Though both involve knowledge which is induced as a consequence of adaptation to the regularities in one's experiences, it is implicit knowledge which governs the child's ability to process and comprehend speech or print. This implicit knowledge emerges earlier and is quite separate from metalinguistic awareness, which entails the ability to focus upon, think about, or make judgments about the structures comprising language. In her investigation of the emergence of inflectional rules in speech, Berko (1968) devised a clever way of exposing the child's implicit knowledge. To study past-tense rules, she presented a picture of a man with a steaming pitcher on his head and said, "This is a man who knows how to spow. He is spowing. He did the same thing yesterday. What did he do yesterday? Yesterday, he _____." Despite the fact that he has never heard this verb, the child who possesses implicit knowledge of the rule will promptly reply "spowed." If Berko had asked the child to talk about the rule directly or to analyze and make judgments about inflectional forms, she would have tapped metalinguistic awareness rather than implicit knowledge and the child may not have been able to respond successfully. This distinction is important to maintain in investigations of linguistic capabilities. For any task or behavior, one must consider which level of knowledge is being reflected in order to assess its significance for linguistic development. As will be evident, both metalinguistic awareness and implicit knowledge are important aspects to study as part of learning to read.

One final point to be made about the reading process is that reading resembles the listening side of speech, not the

production side. Though readers may pronounce or subvocalize the words they are viewing, their efforts are directed at getting someone else's message, not finding words to express their own thoughts. Thus, what they see is more important than what they say. In their encounters with print, it is essential that they recognize word identities. It is not essential that they be able to say words accurately in order to derive appropriate meanings. This distinction can be illustrated with a few examples. A speaker of black dialect reading a text aloud might fail to add past tense inflections to verbs despite their presence in print. However, the fact that the speaker is recognizing and interpreting these time markers becomes evident when he encounters the graphically ambiguous verb "read" and pronounces it correctly as /red/ (Labov, 1967). Another speaker might pronounce three very different words ("in," "it," and "if") all identically as "ih" (Bereiter and Englemann, 1966). However, in reading, the speaker has little trouble discriminating and recognizing these words since their graphic identities as well as their syntactic identities are quite different In speech, it is clear that children do not have to be able to reproduce sounds in order to perceive the relevant contrasts. What they hear is not necessarily reflected in what they say. Slobin (1971) gives an example of a child who pronounced her own name "Litha" yet, from an adult, would accept only the pronunciation, "Lisa." Furthermore, accurate perception in reading can occur in the absence of any speech production. This is demonstrated by the high reading speeds which some proficient readers are able to achieve. All of this suggests that the sorts of cognitive structures formed from interaction with printed language will be primarily perceptual rather than behavioral in nature.

Learning to Read: Word Consciousness

To determine what the child needs to learn about printed language in order to read, it is necessary to consider what he knows about spoken language. Though there are some syntactic structures he has not learned (C. Chomsky, 1972), the six to seven year old child possesses the phonological and syntactic equipment necessary to comprehend and produce most forms in speech. Although his semantic system is still under-

developed relative to the growth remaining (McNeill, 1970), the child has acquired sufficient terminology, concepts, and knowledge of his world to understand and talk about many of his experiences. Thus, the beginning reader appears to possess the phonological, syntactic, and semantic equipment needed to process the meanings of printed sentences whose structure and content are familiar to him in speech. What remains for him to learn is how to integrate printed language into his linguistic system so that he can use his knowledge to interpret graphic cues.

In a consideration of the various ways this relationship between print and the linguistic apparatus might be achieved, it is obvious that print cannot be inserted directly at the level of meaning, for graphic symbols do not correspond in a one-to-one fashion with meanings. This is in contrast to pictures which may match up quite well to the images the child forms when he represents and thinks about the world. Nor is it likely that printed language is fed directly into the phonological component. The basic elements of the phonological system are sounds, and, as discussed above, letter sequences do not represent acoustic-phonetic patterns reliably enough to enable a person to reproduce speech with much accuracy. However, if printed language receives prior analysis into sequences of abstract word units whose linguistic identities are recognized, then its spoken form becomes evident and sound values can be related to letters where there exist correspondences. This suggests that what the beginner needs to learn is how to convert graphic cues to recognizable words.

Since the ability to recognize words appears to be central, it is important to examine what the beginner knows about words in his speech. Clearly, he possesses substantial implicit knowledge of words as units. He can combine and recombine them to produce a variety of sentences. He can even treat nonsense sounds lodged in meaningful sentences as words, infer the correct form class, and apply inflectional endings, as Berko's (1958) work has shown. However, examination of his metalinguistic awareness of words as constituents of sentences discloses that this capability is surprisingly underdeveloped. Huttenlocher (1964), Holden and MacGinitie (1972), as well as Ehri (1975) provide evidence indicating that five to six year olds who have not yet learned to read have much trou-

ble analyzing sentences into component words. Especially pronounced is the difficulty in identifying functors, that is, words performing syntactic-relational roles and lacking much independent semantic identity (i.e., determiners, auxiliary verbs, conjunctions). For example, Holden and MacGinitie (1972) had children lay down poker chips as they spoke each word of a sentence. They found that *S*s would group words such as "to," "is," and "the" with preceding or following content words, and these choices appeared to be influenced by the intonation patterns imposed upon sentences (e.g., the book /is in/the desk.), not by any fixed perception of units and boundaries. Also, Reid (1966) and Downing (1970) show that beginning readers have trouble identifying what a word is and distinguishing this concept from the concepts of letter, number, and sound.

The fact that a child lacks conscious awareness of word units and word boundaries is not so surprising in light of his experience with language. He has acquired linguistic competence as a consequence of his interaction with others and his attempts to share meanings through speech. The course of his linguistic development has thus been regulated by the meanings he has understood and the meanings he has struggled to express. This interaction has not required him to focus upon single word units and to think of them as entities apart from their contexts or meanings.

These observations suggest that one change which may occur when the child learns to read is that he becomes aware of words as constituents of his language. In Ehri's study (1975), some evidence for this is presented. She found that first-grade readers were much more successful than kindergarten prereaders in identifying and manipulating words in oral speech and in distinguishing words from syllables. Although Ehri's findings indicate a relationship between learning to read and becoming aware of words as units of language, the nature of this relationship remains uncertain. It is not clear whether word consciousness is a consequence or a cause of learning to read (Ehri, in press). It may be that word consciousness results from interaction with an adaptation to printed language. However, an alternative view is that word consciousness is a prerequisite for learning to read, and that children who are successful have already learned to segment speech into words. The latter

position implies that children can become aware of word units and word boundaries without having language materialized in print, whereas the former position suggests that experience with printed language is necessary in order to learn how to analyze language into words.

A study by Thomson (1968, described in Cazden, 1972, p. 266) indicates that prereaders can learn to identify lexical units embedded in meaningful, orally presented sentences. He was able to teach both lower- and middle-class children to repeat backwards three-word phrases (i.e., "a higher tree," "He took it"); and he found that, once learned, the children could apply the analytic strategy to test phrases. This study yields some evidence that prereaders may be able to access their lexicons if given appropriate oral training. Further investigation of this possibility and its relationship to beginning reading is needed.

Although it may appear straightforward, the process of learning to segment speech into words and to become aware of words as units has some complexities which must be considered. Up to this point, it has been assumed that there is no discrepancy between the units specified as words in printed language and the units functioning as words in spoken language. Although this may be true for people who are literate, it may not be true for prereaders. It is not at all clear what effect learning to process printed language has on the structure of one's linguistic system. It may be that print serves to form words in a reader's mind rather than simply to make the reader conscious of words. Or it may be that print forces the child to restructure units of his language.

One argument in support of the notion that print actually fashions words in the child's linguistic system rests upon the point that different languages have different systems for segmenting speech into words. Whereas in some languages prepositions or articles are combined with nouns to form one unit in print, in other languages these units are designated as separate words. Printed English adopts a particular set of word conventions, and it is this which the beginning reader learns and this which determines the segments he perceives in speech. In reaction to this argument, it must be acknowledged that conventions are needed by the child to clarify which units are words, and so in this sense he does not have word knowl-

edge prior to his encounters with print. However, it also appears true that these conventions operate at the morphological level which is close to the word level in English. That is, these rules specify whether various classes or morphemes are to be combined or separated. Since the child already has implicit knowledge of these morphemic units, as evidenced by the fact that he combines and recombines them routinely in his speech, his task is not to learn the units from scratch but simply to learn whether they are represented alone or as part of other units. Furthermore, since many morphemes in a beginner's print vocabulary are represented as separate words in English, he has relatively few combinations to learn.

In order to gather evidence on this matter, one needs to examine how the child's metalinguistic knowledge of word units emerges, particularly how rapidly it appears, and whether it involves learning abstract rules which can be generalized to new instances never seen in print or whether the child must observe each unit in print in order to know whether it is to be attached to its neighbors or kept separate. If it is the case that experience with print simply arouses word consciousness rather than teaches word segmentation, one would expect word analytic skills to be acquired quickly by the beginning reader and to entail the learning of form class rules rather than specific instances. For example, by attending to the location of word boundaries in noun phrases and combining this with knowledge about the form class of words, the reader might induce the rule that nouns are represented separately from adjectives. If this is the case, then he should be able to recognize how adjective-noun combinations, familiar to him in speech but never before seen in print, are segmented.

Acquiring Word Identities

It has been suggested that in order to become conscious of words as units of language, the child may have to learn how these units are materialized in print. Before inquiring into the processes by which graphic identities of words are learned, it is important to point out how facile a literate adult is with words, how salient these linguistic units are to him. He can write them, say them, glance at them, imagine what they look or sound like, laugh at them. In fact, if asked to describe what

language is, he will very likely talk about words. For reading, perhaps the most important aspect of his dexterity is that, given a particular word in print, he can instantly recognize its full identity. The Stroop phenomenon, for example, gives evidence of the automaticity of semantic identities, Tachistoscopic studies indicating that letters are more quickly recognized in words than in isolation also suggest that graphic identities are readily available. In short, to the mature reader, a single printed word exists as a holistic unit, a gestalt, and it derives its integrity not simply from its letters but from all its aspects—letters, sounds, syntactic functions and meanings.

In contrast to the experienced reader, the beginner sees very little when he looks at printed words. His major task in learning to read is to achieve this rich lexical perceptivity. From the above discussion, it is evident that in order for this to happen, printed language must make contact with the reader's linguistic system, and contact must be made at the level of words. Since the beginning reader knows only one way of representing words, as sounds in speech, he must necessarily depend upon print-speech word relationships in his attempt to recognize graphic patterns. However, being able to produce the oral correlate of a single printed word may not guarantee the journey from print to recognition of the word's full linguistic identity. There are several facts which make this so.

First, examination of the child's experiences with spoken language reveals that he has had little practice recognizing single words, especially words other than nouns and adjectives. Rather, such words have always been encountered in contexts and he is used to thinking about the meanings of phrases or sentences, not individual words. If given the task of learning to see and say words, it is likely that he will not recognize the spoken forms as having any linguistic identity. If he learns anything, it may involve merely the ability to bark at print (Goodman, 1973).

Second, examination of the locus of word identity reveals that is is not really lodged in an individual isolated unit but rather in the unit as it is related to a particular context. This is especially true for function words which are essentially meaningless if presented alone. Many words, especially very frequent words, have several possible interpretations. Furthermore, words can be ambiguous syntactically as well as semantically. For example, the word *cooking* can function as a noun,

a verb, and an adjective. Interestingly, Goodman (1969a) observed that younger readers made many oral reading errors on *-ing* adjective forms, perhaps because they mistook them for verbs, the most common syntactic identity for this form.

These facts suggest that for the beginning reader, it may be difficult if not impossible to recognize and learn linguistic identities when printed words are merely sounded orally and no context is provided. This may be so not only because the child has trouble using isolated phonological forms to retrieve identities from his lexicon, but also because a number of alternative identities are available and there is nothing in the stimulus suggesting which is intended. Oakan, Weiner, and Cromer (1971) present some evidence for this difficulty. They trained poor fifth grade readers to read aloud from flash cards all the words appearing in a story and found that this did not boost comprehension of the story above that occurring without training. This method may have failed because only the word's phonological appearance, not it syntactic and semantic identities, was associated with the graphic cues by these readers.

Automatic recognition of a word from its graphic form is probably a consequence of extensive experience seeing that word in context and building up a complete linguistic identity around it. Evidence from various sources suggests that less proficient readers do not respond to single words as more mature readers do. Felzen and Anisfeld (1970) read a list of words to children and had them judge whether the word had appeared before on the list. Whereas third graders mistook words which were phonetically related (rhyming words) more frequently than semantically related words, sixth graders erred more on semantically similar words. These findings indicate that semantic identities of single words may not be as salient to younger children hearing phonological identities as they are to older children. Lott and Smith (1970) compared children's recognition threshholds for letters in words to letters in nonwords. Although younger children displayed reduced threshholds to words, the magnitude of this reduction was not as large as that for adults until the fourth grade. This suggests that graphic identities require some experience in order to become fully established, integrated and automatic.

Given that a beginning reader sees relatively little when he views a printed word, it is important to inquire how rapid word recognition capabilities are established. Clearly words

need to be embedded in meaningful contexts in order for complete linguistic identities to be aroused. Once a child has learned to recognize a few words from their graphic forms, he can begin processing printed text. Having familiar lexical landmarks present in print, he may be able to use the syntactic and semantic information recognized in these known words to identify unknown printed words as he derives meaning. By encountering the same words repeatedly and guessing correctly at their identities, he may be able to expand his repertoire of familiar printed words.

According to this view, unfamiliar printed words get their identities from the way they are perceived in the context of other words during the reading process. The reader pays attention to and associates with a printed word those cues which are active at the time he sees the word and which are distinctive for that word. There are several sources from which he can draw cues to associate with printed letter configurations. He has available phonological information about how the word is pronounced or how it sounds. He has available syntactic cues involving the word's role in sentences and its structural relationship to other words preceding and following it. (This source of cues for words will be elaborated in the next section.) And he has available semantic cues about the word's meaning. To the extent that phonological, syntactic, and semantic information is amalgamated with the graphic features of words, and to the extent that this is represented and stored as one unit in his lexicon, the reader acquires a very rich base for discriminating among printed words and instantly recognizing their identities.

In this connection, it is important to note that only spoken cues receive some physical representation in the printed word, in terms of letters corresponding to sounds. The other identities—syntactic and semantic—do not. This contrasts with logographic print systems where there is a relationship between the printed symbol and its meaning. However, though English words are not logographs, the Stroop phenomenon suggests that words come to function like logographs once the reader has had sufficient experience with print. Furthermore, not only semantic but more importantly syntactic cues about the word's role in sentences come alive in the experienced reader's head when he views familiar letter configurations.

Perhaps because many researchers have been preoccupied with the nominal rather than the effective stimulus (Rothkopf, 1970), they have slighted these cue sources which comprise the good reader's lexical cognitive structures and which enable him to identify words in an instant.

This description of the process of acquiring word identities suggests that reading words in contexts is essential for learning to recognize them from their graphic forms. It is important to look at evidence indicating what beginning readers do with unfamiliar words as they read. It appears that initially the identities imposed upon a new word are primarily syntactic and semantic rather than phonological, that these cues are amalgamated with only some graphic symbols in the word, and that only gradually the full printed form becomes associated with the abstract form stored in the lexicon. In the analysis of oral reading errors, Goodman (1969a) found that key phonemic elements were preserved among second graders only 26 to 30 percent of the time. Clay (1968) reports that 41 percent of kindergarten readers' substitution errors indicated that they were responding on the basis of visual letters. However, 79 percent of their errors indicated response on the basis of grammatical form class. Weber (1970) found that over 90 percent of the substitutions she observed among first graders were both grammatically and semantically consistent with the preceding context. This evidence suggests that beginning readers are more apt to attend to syntactic and semantic identities of unfamiliar words as they read than they are to phonological or graphic details. That syntactic and semantic cues emerging from a word's context provide much support for correct word identification is suggested by Goodman (1965) who found that first, second, and third graders could read at least half of the words correctly in a story that they could not recognize on an isolated word list. C. Chomsky (1974) reports that readers were often surprised to discover that words they thought were unfamiliar when viewed in isolation were actually known when their contexts were exposed. However, even when correct phonological identities are available, it appears that beginning readers attend to only some of the letters in learning to read new words. Samuels and Jeffrey (1966) found that beginners given a list of printed words to learn by the whole-word method paid attention to only the first or last

letters, not to letters within the word. This was indicated by their tendency to confuse these words with new words having the same boundary letters. Tinker (1965) cites several studies indicating that children pay attention only to certain letters or letter groups in identifying words.

This evidence bearing on the process of acquiring word recognition capabilities through seeing words in contexts suggests that it may take extensive exposure for at least some words to achieve status as printed gestalts since the beginner can use contextual cues to guess successfully and since he fails to pay close attention to graphic details even when he knows how the word is pronounced. (In the latter case, presumably since he knows the word's sounds, he could analyze and store correspondences between letters and sounds.) There is another observation which is consistent with this picture and which suggests that the process may be even more protracted in time. Weber (1970) reports that in their word substitution errors, first graders drew the large majority of their erroneous responses, not less than 95 percent, from words they had already met in their books. That is, rather than attending to grapheme-phoneme correspondences or experimenting with words drawn from their general lexicons, these children limited their perceptions to a subset, a print lexicon. It may be that her subjects lacked adequate word-analytic skills. However, if her observation characterizes accurately what beginners do, then it suggests that a beginner's knowledge of printed word identities may grow very slowly if at all from his experiences seeing unfamiliar printed words as he reads. This poses a problem for the process of acquiring word identities suggested above. It seems clear that the child needs to experience printed words in contexts in order to recognize their full linguistic identities and to amalgamate these to graphic cues. Yet seeing words in contexts reduces the need to pay attention to their full printed forms.

Perhaps explicit instruction or practice in word identification may be required to facilitate growth of a print lexicon. C. Chomsky (1974) mentioned some ways of doing this, ways which direct attention to orthographic features yet preserve the contextual identities of words. She had readers place a frame around individual words appearing in a printed context, attempt to identify that word in isolation, and then expose its

context for verification. This might be one means of assisting beginners in amalgamating not just a word's sounds but all of its identities to its graphic form. Another method for facilitating the recognition of new words was to intersperse tape recordings of a passage with attempts by the child to read the text himself. The child would listen to the story and try to follow the words in print with his eyes. Then he would attempt to read the story without the tape. Listenings and readings were alternated until the child was able to read the story. Then he was given a new story. Chomsky observed that subsequent stories required fewer listenings to achieve fluency. This method appears valuable in that it instates the appropriate phonological identities for new words while at the same time maintaining ongoing syntactic and semantic patterns. Also, it gives the child repeated exposure, practice and feedback in recognizing a given set of printed words. LaBerge and Samuels (1974) stress the importance of automaticity as an objective of beginning reading.

In order to direct children's attention to the relationships between letters comprising known printed words and sounds in the word, Chomsky created various word-analytic games. In these games, analysis was conducted not for the purpose of learning to use speech to decode new printed words but rather for the purpose of analyzing and learning the letter-sound relationships in words whose linguistic identities were already recognized. It may be that letter-sound correspondences are less useful for discovering the identities of unfamiliar words than they are for helping the beginner notice and remember many of the letters comprising known words. Although highly suggestive, Chomsky's report is anecdotal, and it remains to be determined what sorts of experiences are critical in enabling readers to become proficient at recognizing the full linguistic identities of words from their graphic forms and enabling them to store complete orthographic forms in lexical memory. Clearly, these are the sorts of factors and processes which should prove important.

Synthesizing Words into Sentences

The process of reading requires not only word recognition but also word synthesis. A reader must organize sequences of

words into phrases and sentences so he can process their meanings. It is important to examine how word synthesis is accomplished by the reader. The model of linguistic competence described above suggests that syntactic processing takes place in the reader's head, not on the printed page. That is, information about how words are to be grouped into a hierarchy of phrase structure constituents and how grammatical relations are to be assigned comes from the linguistic system already programed in the reader's mind as a consequence of his competence with spoken language, not from specific cues in the stimulus. One can demonstrate that information needed to organize and interpret sentences may not be present in the stream of sound or in individual words comprising sentences. For example, nothing in print tells the reader how to achieve two different syntactic patterns for the following sentences:

They are cooking apples.

The shooting of the hunters was terrible.

The words as well as their separate meanings remain the same for both patterns. What shifts in the two interpretations are the structural patterns or relations among the words, and this restructuring is controlled by rules in the reader's head. Another type of sentence further illustrates that cues on a printed page are of little use in determining which words go together in sentences. Syntactic rules, not proximity of words, identify who ran home in the following example:

The dog that bit the cat ran home.

Given that syntactic processing is handled by the linguistic system, it is necessary to establish what the reader needs to extract from print in order to enable his syntactic rules to operate and how such information is used to process a line of text. According to the linguistic model proposed above, the syntactic system requires that three things be known: the grammatical form class of each word, how the words are ordered, and where a sentence begins and ends. Information about form class constitutes part of the word's syntactic identity lodged in the lexicon. The beginner as well as the proficient reader presumably has this syntactic word knowledge already available to him as a consequence of his linguistic competence. However, the beginner may not be able to recognize this identity from the graphic forms of words or from their phonological

forms if they are heard in isolation. Furthermore, there may be ambiguity about the form class of some words (e.g., *cooking*). However, the reader has available another source of information about form class. Words preceding any particular word in a sentence may delimit if not determine the grammatical form class of that word. Thus, the syntactic pattern into which that word must fit may resolve ambiguities or otherwise clarify a word's syntactic role before it is even seen. In such cases, a word's position in a sequence and its grammatical form class are redundant sources of information for the reader.

Information about word order and grammatical form class is necessary in order to set up syntactic patterns among words. For example, upon encountering the determiner *the*, a reader predicts and becomes prepared to process succeeding words as a noun phrase. He is ready to see either an adverb, adjective or noun next. Not only determiners, but also other classes of words—active transitive verbs, prepositions, relative pronouns, conjunctions—have this effect of setting up syntactic patterns for subsequent words. In contrast, nouns, some pronouns and intransitive verbs perform an opposite function, that of terminating a phrase or sentence. Not simply single patterns but multiple embedded patterns are carried as a reader processes text—one subordinate unit beginning and terminating in the middle of or as part of another superordinate unit. For example, the reader sees the first word and predicts a noun phrase as well as a sentence pattern in the following sequence:

The red house that Jack built burned down.

Upon encountering *that*, the reader adds a second sentence pattern to the first, holding the first in abeyance until he fills in the relative clause. The reader is able to keep track of and coordinate the opening and closing of several such patterns in his head as a consequence of his linguistic competence. As he moves across a line of print, he processes each word in terms of the syntactic patterns predicted and the slots to be filled. As he comes to each word, he uses the syntactic pattern to make a prediction about the word's grammatical form class, selects a word in his lexicon fitting that description and possessing at least some of the graphic features appearing in print, fits this word into the slot, and proceeds to the next word repeating the same operation. Each word is processed in the order necessary

to open, complete, and close the multiple syntactic patterns aroused for each sentence.

This description of reading is consistent with evidence gathered regarding children's oral reading behavior, specifically the nature of their reading errors. One of the most salient features of performance reported by numerous investigators (Weber, 1970; Clay, 1968; Goodman and Burke, 1968) is that when children run off the track in their reading, what they produce is grammatically appropriate with the preceding context. As mentioned above, Weber observed this to happen over 90 percent of the time. Furthermore, she found that less advanced beginners were not any less inclined to do this than more advanced beginners. This suggests that from the start, readers utilize syntactic patterns for processing what they read. They do not gradually acquire this capability.

Grammatical form class appears to play a central role in determining the predictions which a reader makes regarding word identities. Kolers (1970) found that adults reading geometrically transformed text substituted for nouns, verbs, and prepositions words from the same class about 75 percent of the time. For the other classes, this occurred about half the time. For her young readers, Weber (1970) observed that 64 percent of the word substitutions were of the same form class. Clay (1968) provides evidence for the form class identity of single word substitution errors as a function of reading ability. Whereas the two lower ability groups of five-year-olds produced substitute words from the same morpheme class 86 percent and 82 percent of the time, the two higher ability groups did this 72 percent and 81 percent of the time. Clay's data suggest that even the beginner uses his linguistic competence to limit his perceptionof words encountered in a line of text. This is not something acquired as he learns to read.

As discussed above, words occupying superordinate positions in a phrase structure hierarchy must necessarily be seen first since they set up the syntactic patterns for subsequently appearing words lower down in that branch of the hierarchy. Thus, it is essential for beginning readers to feed words into the system in the correct order to insure that appropriate syntactic structures are erected. Analysis of oral reading errors confirms that beginners very early learn to control word order. Weber (1970) reported that scrambling of words accounted for only 2

percent of the errors. Y. Goodman (1971) observed word reversals to occur less than 1 percent of the time in her young readers.

Information about word order reaches their syntactic systems by virtue of the fact that beginning readers in processing printed language look at only one word at a time. In contrast, the findings of Levin and Kaplan (1970) and Resnick (1970) indicate that more proficient readers proceed more rapidly and process several words at a time. Using an eye-voice span task which measures the number of words that the eye is ahead of the voice, Levin and Kaplan found that faster and older readers had longer eye-voice spans than slower or younger readers and that eye-voice span tended to expand or contract to end at a phrase boundary for all but the youngest readers (second graders) who appeared to see only single words in one glance.

It is of interest to question how more mature readers are able to extend their perceptual spans to include several words in light of the claim that text must be processed word by word in order to erect syntactic patterns. As discussed above, proficient readers are able to recover the full identities of printed words in one glance, so this capability very likely contributes to their extended perceptual spans. However, this fact alone does not explain why the size of spans is not constant, why it varies as a function of phrase structure. Two alternative accounts for this phenomenon can be developed, both grounded on the point that within a phrase there is only a limited number of ways that words can be arranged to form a syntactically acceptable sequence. It may be that once syntactic identities are amalgamated with graphic forms so that the reader can in a glance recognize the form class of words, he has less need to attend to word order in cases where only one arrangement is possible. He leaves it to his syntactic system to order the words. Alternatively, it may be that, as the reader becomes highly practiced in processing text, gestalts larger than single words become established as graphic templates in his linguistic system and enable him to see phrases in one glance. Whereas the first explanation suggests that actual word order goes unnoticed within a phrase, word order is central to perception of phrases according to the second explanation. One way of testing these alternative hypotheses might be with an eye-voice span task in which word order violations are introduced

within phrases but just beyond the point where the text is pronounced by the voice and blocked from view. If word reversals elude detection and fail to impede perception of the phrase, this would contribute evidence in support of the hypothesis that word order has become redundant information to be slighted by the proficient reader.

In terms of the process of acquiring word identities, the word integration operations discussed above suggest that what may happen in learning to read is that initially the reader must plug a word into an ongoing pattern in order to recognize its syntactic identity. However, as a consequence of much experience doing this, the syntactic cues activated at the time the word is seen get amalgamated with its printed form and enable the reader to recognize how the word functions syntactically in the absence of a meaningful context. Some evidence for the superior ability of good readers to recognize syntactic identities comes from a study by Weinstein and Rabinovitch (1971) who found that good fourth grade readers were able to learn sequences of nonsense syllables containing syntactic structural cues (e.g., *When they sivoled the veg, they hanashed zalfly.*) more rapidly than unstructured sequences. (These stimuli were presented orally.) In contrast, poor readers were unable to make use of the structural cues and so found both types of sentences equally difficult to learn. The ability to recognize syntactic identities from graphic forms may prove to be an especially important factor enabling a reader to move rapidly in processing text.

It has been suggested above that as initial words in a sentence are successfully identified, the syntactic structures possible for that sentence are activated and direct the perception of subsequent words. It is important to discuss what sorts of factors should and should not make a difference in reading, according to this view. Mackworth (1974) has proposed that unless the reader is able to process words at a rate of more than one per second, his iconic store will not be able to retain enough words to interpret what he reads. The view presented here, however, suggests that reading rate is not the critical factor, that it is merely a consequence rather than a cause of poor reading, and that it results from a failure to recognize word identities and predict syntactic patterns. Note that time is quite unimportant once a syntactic pattern is

established by a word. In speech, people quite frequently introduce long pauses in the middle of sentences or they speak haltingly as they develop and express their ideas; yet the listener's ability to comprehend the message is not impaired. So long as he can hold the pattern in mind, he can wait quite awhile for the rest of the sentence.

Another proposal offered is that readers sample texts for cues and that in doing this they pay particular attention to syntactic markers and inflectional endings (e.g., The _____ is _____ing a _____s.) for organizing words into syntactic patterns. Goodman (1968) is one proponent of this point of view. Jones (1968:51) describes a similar proposal by Yngve who

> . . . hypothesized that a sentence can be considered as a structure of frequent morphemes with various open positions into which the infrequent morphemes and new words fit. The frequent morphemes and their combinations are role markers for infrequent ones and are important for stating syntactic patterns.

The proposal is that readers use these frequent markers to plot sentence patterns and then they fill in the gaps with content words. This hypothesis can be linked with another asserting that readers use peripheral search guides (printed cues picked up in the periphery of the eyes) to prepare the way for subsequent details (Hochberg, 1970). Presumably role marker morphemes serve as the advance syntactic organizers. These proposals contrast sharply with the word identity amalgamation view developed in the present chapter. This alternative position suggests that words are seen as whole gestalts, that all words receive equal attention in print, and that though some words may be recognized more quickly than others, they are processed in the order appearing in text. Syntactic markers are important not in terms of the way the reader's eyes move around and focus in a text but rather in terms of the patterns they trigger in his linguistic system. One means of obtaining evidence on this matter might be to compare reading performance on a standard text to performance on a text altered to highlight these sentence pattern cues (i.e., markers underlined or printed in larger type). It is reasoned that if such cues provide especially valuable information to readers, then making them easy to detect should speed up the reading process.

In examining how the beginning reader might put words together to form sentences, one must consider the role of speech in this process. As stated above, the problem for the reader is to achieve in his oral reading not merely a sequence of oral sounds which correspond to printed letter configurations but rather spoken words which he recognizes as having identities in his linguistic system and which combine to form sentences. In speech, this process is aided by intonation and stress patterns which extend over several words and integrate them into phrases and sentences. The beginning reader apparently does not start out with good intonation. Rather he reads orally word-by-word. Clay (1966, 1969) reports a developmental sequence as children move from this approach to one where oral productions are more natural. Weintraub (1968:67) provides the following description of Clay's findings:

> With some children in Clay's study, there was a gradual transition from finger point to "voice pointing." The "voice pointing" is usually called word-by-word reading. This "pointing" seemed to serve an important function at the beginning stages of reading in that it aided a child in making the one-to-one correspondence between the printed and the spoken word. Eventually, as skills grew, a transition to a lighter stress on individual words and finally to a greater dependence on phrasing and word groups occurred. With fast learners, the transition was so rapid as to be almost unnoticed.

These initial stages of oral reading pose a problem for the present view which suggests that intonation should be evident from the onset of effective reading (i.e., reading in which words are synthesized to form sentences) since it is argued that beginners do not learn to process syntactic relations but that this comes from their heads as they read. However, it is not clear whether Clay's word-by-word readers were processing the words syntactically. Y. Goodman (1971) reports that her beginners did not read word-by-word. Even the poorer readers displayed accurate intonation patterns in their oral reading 88 percent of the time. Thus, it remains to be determined what role intonation patterns play in beginning reading, whether once readers can form meaningful sentences out of words they automatically intone their oral productions or whether there is a stage where syntactic relations might be comprehended but not re-created effectively in oral speech during reading.

One question raised in considering the relationship

between intonation and beginning reading is whether one can facilitate the process of synthesizing words into sentences by giving the beginner clues about how intonation patterns are to be assigned to print word sequences. Ehri and Wilce (1974) investigated this possibility. They constructed a text in which words were printed in one of three sizes to reflect pitch-stress levels which would be assigned to those words if the sentences were spoken. Though preliminary findings were positive, the investigators were unable to replicate the facilitative effects of such text cues on children's reading (Ehri, 1976).

Residual and Concluding Comments

Several questions and concerns become apparent when one considers beginning reading from a psycholinguistic perspective. One concern of the present chapter has been to clarify the relationship between what the beginner knows about language and what he needs to know in learning to read. It appears that the beginner possesses implicit knowledge of the structure of language but that he lacks conscious awareness of words as entities separable from their meaningful contexts. It was suggested that learning to analyze speech into constituent words and, in turn, learning to recognize from single printed or spoken words their syntactic and semantic identities constitute the major tasks facing the beginning reader. Another concern of the present chapter has been to reason about the function of speech in reading. It was suggested that speech plays an adjunct role. In deriving meaning from print, the proficient reader does not pass through the phonological component of his linguistic system. Rather he has acquired a separate graphic component which operates upon printed language. In word recognition learning, rather than helping the beginning reader transform letters to sounds, the most important contribution of letter-sound relationships is to help him analyze and remember the internal makeup of printed words once their identities are known. A third concern of the present chapter has been to figure out how the reader is able to synthesize words into sentences. It was proposed that syntactic processing takes place in the reader's head rather than in print, that it involves utilization of the system he has acquired to comprehend spoken language, and that it requires that he

extract information about word identities, word order, and sentence boundaries from the printed page and coordinate this with his syntactic predictions. Of course, these answers are tentative and await more extensive empirical study.

In the investigation of hypotheses about printed language and reading acquisition, there is one general strategy available which may prove useful in assessing which aspects of the printed stimulus are important. This involves altering one or another feature of print and comparing its effect upon reading to unaltered text. Some examples of this approach are available: Ehri and Wilce's word size variations to reflect intonation patterns (1974); Hochberg, Levin and Frail's use of text printed with the empty spaces between words filled (reported in Levin and Kaplan, 1970). The idea is to determine which printed cues are critical to reading by highlighting or obscuring or violating the structure of those cues in print and assessing the impact of this manipulation on reading performance. If the cue is central to processing, then alterations should make a difference.

Only some of the processes involved in reading acquisition have been considered above. There remain a number of matters which also deserve attention. One is the influence which learning to write has on the emergence of word consciousness, word identity, and knowledge of print conventions. This is certainly another arm of the process, and results of the child's attempts to adapt to the productions of printed language are certain to influence the rest of the system, particularly the sorts of structures and rules which are formed.

Another part of the model of linguistic competence slighted in the present paper is the matter of semantic processing, what the reader compehends when he reads. It was implied that if the beginner accurately identifies the syntactic structures of a text, then he will be able to interpret these structures by simply applying knowledge derived from his competence with spoken forms. However, the matter appears more complex. Goodman (1969) observed that although his subjects' oral reading was quite proficient as indicated by the syntactic and semantic acceptability of their oral reading errors, when asked to retell the story, they displayed moderate and sometimes minimal comprehension. This suggests that the syntactic-semantic processing of single sentences is necessary but may

not be sufficient to insure that information from one sentence will be integrated with information from subsequent and preceding sentences to yield meaning for a passage. Thus, much remains to be explained at the semantic level of the reading process.

In considering the emergence of the child's knowledge of printed language, the present chapter concentrated upon orthographic patterns and little attention was given to other aspects of its structure. Meltzer and Herse (1969) have examined children's hypotheses about what words in general look like. They presented beginning readers with sentences printed without spaces between words and *Ss* were told to locate word boundaries. The less proficient beginners were observed to call upon their own conventionalized notions of a word's appearance; it has from two to four letters and it begins and ends with a tall letter. Meltzer and Herse trace these hypotheses to their subjects' reading experiences. In the books used by these children, a majority of the words had from two to four letters and over 90 percent of the words either began or ended with a capital or tall letter. Beginning readers' knowledge of not only structural regularities of words but also other print conventions (capital letters, punctuation) need to be examined. Weber (1970) reports that children who had read preprimers having sentences which always ended at the end of a line induced this as a general rule. This was evidenced by their tendency to disregarded punctuation and read all line ends with an end-of-sentence intonation pattern. Induction of inappropriate or maladaptive rules of printed language are especially important to investigate.

Although one might expect the location of word boundaries to be quickly mastered and centrally important to beginning readers since these cues help them identify the units of printed language, there is some doubt about this. Hochberg, Levin and Frail (reported in Levin and Kaplan, 1970) found that second graders' reading was little impaired by filling these empty spaces with a printed symbol. Mickish (1974) reports that several of her better first grade readers were unable to locate word boundaries in a sentence which contained familiar words but no boundary cues and was read orally to the children. Although white spaces tell beginning readers when to begin and when to cease processing a sequence

of letters as a word, it may be that white spaces do not facilitate word perception until the configuration within the boundary is recognized as a familiar integrated printed unit, a gestalt.

In addition to suggesting various lines of research to clarify what happens during reading acquisition, the word amalgamation view developed in the present chapter carries implications for various programs designed to facilitate beginning reading. As explained above, any method which teaches beginning readers to recognize the full linguistic identities of single printed words should contribute to their progress. In this regard, there are two programs which deserve mention, both of which modify the printed form of the words being read. One is the use of an initial teaching alphabet (i.t.a.) which alters the spelling of words so that letter-sound correspondences are regularized (Harrison, 1964). The other involves the use of a syllabary in which words are represented and recognized in terms of component syllables (Gleitman and Rozin, 1973). Although these methods may prove beneficial for other purposes such as helping the child analyze the relationship between sounds in speech and printed language, these methods may retard the learner's progress in amalgamating word identities to their printed graphic forms. At some point in these programs, the reader will have to switch printed cues from those unique to the program to conventional cues, and this will require additional time for adaptation to the new system. Whether it is worth the time in terms of what is gained initially becomes the critical question.

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Access to the Meanings of Printed Words: Some Implications for Reading and for Learning to Read[1,2]

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We teach children to read so they can obtain meaning from printed words. Although it is unlikely that anybody would disagree with this statement, there has been very little research, at least until recently, about whether fluent readers always obtain access to the lexical meanings of printed words by first decoding them into sound, or whether the visual pattern of the word provides sufficient information for meaning access. Do the strategies for accessing meaning from printed words change developmentally and to what extent are they dependent upon the reader's knowledge, purposes, and ability to pronounce printed words? The answers to these questions could have substantial implications for conceptions of the fundamental processes involved in reading and for directions taken in reading research and reading instruction. The controversies, for example, over spelling reform and the whole word versus phonics approach to beginning reading are based, at least in part, upon differing conceptions of how beginning and fluent readers obtain access to the meanings of printed words.

Although information about the ways in which meaning access can take place would seem to be central to the development of the psychology and pedagogy of reading, there are several reasons why this problem has been ignored or research related to it has proceeded in a piecemeal fashion. First, many investigators in the area of reading (Bloomfield, 1942; Fries,

[1] The author gratefully acknowledges the comments of J. Baron, R. Briggs, L. Brooks, M. Coltheart, J. Danks, B. Durding, L. Henderson, C. Perfetti, N. Rader, and S. Urquhart on an earlier version of this manuscript.

[2] The term lexical meaning refers to an internal lexicon or mental dictionary which provides information about the set of concepts or components which characterize the meaning of a word. In addition, the lexicon contains information about how a word is spelled as well as its phonological, morphological, and syntactic properties.

1962; Gleitman and Rozin, 1977; Liberman, Shankweiler, Liberman, Fowler, and Fischer, 1977; Rozin and Gleitman, 1977) have argued that phonetic segmentation and decoding print into sound are the major obstacles in learning to read. It is possible that these investigators assume, at least implicitly, that once these skills have been mastered then auditory and/or articulatory information can be used to retrieve word meanings. In other words, they assume that the problem of access to meaning is solved once the child can be taught how to pronounce printed words. Second, rather than deal with how we initially obtain access to word meanings, most of the research relevant to reading comprehension has dealt with questions such as how meaning is represented in memory (Kintsch, 1974), the processing operations involved in understanding sentences (Carpenter and Just, 1975), the role of extralinguistic knowledge in remembering and understanding (Bransford and McCarrell, 1974) and the control of strategies for learning from text (Anderson and Biddle, 1975; Frase, 1975; Rothkopf, 1972). Third, many investigators in the area of word perception have been concerned with what role units smaller than single words (e.g., features, letter clusters, spelling patterns, syllables, vocalic center groups) play in how words are perceived and, for this reason, the role of meaning in word perception may have received less attention. There are, however, exceptions to this trend (Barron and Pittenger, 1974; Barron and Henderson, 1977; Chambers and Forster, 1975; Henderson, 1974; Manelis, 1974; Rumlehart, 1977). Finally, some rather influential models of information processing in word recognition (Gough, 1972; Sperling, 1967) have placed semantic processing at the end of a long series of processing operations. Consequently, the problem of meaning access has been either ignored or it has been implicity assumed that detailed knowledge about earlier processes can be used to understand it (see Henderson, 1977, for further elaboration of this point).

It is obvious that readers sometimes use phonetic (auditory/articulatory) information to get to the meanings of printed words, whereas graphemic (visual pattern) information is used on other occasions. For example, a phonetic strategy might be used to obtain access to the meaning of a word that we have never seen in print. On the other hand, the use of graphemic information would be unavoidable when we en-

counter items which, if pronounced, could not be used to retrieve meanings (e.g., lb., sq., Ala., Fla., Ont., Ill.) or when we are required to distinguish between two printed homophones (Baron and McKillop, 1975) and the available context does not provide enough information for a completely unambiguous interpretation (e.g., I want to buy a pear [pair]).

Despite the above evidence that both phonetic and graphemic information can be used to retrieve word meanings, there are conflicting notions of how the process of meaning access actually takes place. Some investigators (Gough, 1972; Rubenstein, Lewis, and Rubenstein, 1971) have argued that we can only obtain access to the meanings of printed words through a phonetic (auditory/articulatory) representation. They propose that the graphemic representation of the word must be decoded into a phonetic representation and it is this representation which is used to obtain access to meaning. In contrast, other investigators (Baron, 1973; Barron and Baron, 1977; Meyer and Ruddy, 1973; Kleiman, 1975) argue that the meanings of a printed word can be accessed directly from it's graphemic (visual pattern) representation. The major issue, however, between these two groups of investigators is whether an intervening phonetic stage is necessary to gain access to the meanings of printed words or whether access to meaning can take place directly, and as efficiently, on the basis of graphemic information (i.e., whether graphemic information alone is sufficient).

It will be argued that the evidence indicates that a phonetic stage is not necessary in order to obtain access to the meanings of individual printed words, even for children who have had less than one year of formal instruction in reading. It will also be argued, however, that phonetic recoding plays a critical role in the comprehension of printed connected discourse by providing the reader with a strategy for maintaining in memory the wording of, for example, a sentence long enough for that sentence to be comprehended (Baron, 1977; Kleiman, 1975; Levy, 1975; Smith, 1976). In other words, phonetic recoding does not appear to be necessary for obtaining access to individual word meanings per se; rather, it provides a means of holding individual printed words in memory until they are understood.

Evidence that Phonetic (Auditory/Articulatory) Information is Necessary to Access Meaning

One of the major advantages of a system in which the lexical meanings of a word are retrieved phonetically is that a common mechanism (speech) can be used to account for both reading and listening comprehension. If it could be demonstrated that a common mechanism was involved both in listening and reading, then a great deal of the mystery might be removed from the reading process. Researchers, for example, could study comprehension and word perception confident that the input modality of the language (visual or auditory) made little difference. Similarly, educators could concentrate their efforts upon teaching decoding skills confident that reading comprehension would automatically equal listening comprehension once the decoding skills had been mastered.

The lexical decision task (Rubenstein, Lewis, and Rubenstein, 1971) has been a popular method for investigating the role of phonetic mediation in word recognition. In this task, subjects are instructed to decide whether a word is English (*clear*) or not (*creal*). Apparently, this decision requires that the subjects first obtain access to their internal lexicon or mental dictionary (see note 2). Rubenstein et al. (1971) used the lexical decision task to find out whether access to the internal lexicon is phonetically mediated by comparing subjects' performance on two classes of orthographically legal nonwords. They found that subjects were slower at making a negative response (*no*, it is not an English word) when the nonwords (*brane*) had the same pronunciation as the English words (*brain*) than when they did not have the same pronounciation (*melp*). Rubenstein et al. (1971) interpreted their results in terms of a model in which access to the lexicon could only take place on the basis of a phonetic rather than a graphemic representation of the word. They argued that *brane* is recoded phonetically and compared to a phonetic representation of its homophone (*brain*) in the lexicon. Although *brane* passes this initial phonetic check, it is rejected in a subsequent check of its spelling (orthography) because it is not an English word. The nonwords which do not sound like English words (*melp*) are rejected more rapidly because they are unable to pass the initial phonetic check. They argued that if phonetic recoding had not taken place prior to

gaining access to the lexicon, then *brane* and *melp* would be rejected with equal speed. In a subsequent experiment with words, Rubenstein et al. (1971) found that *yes* responses to homophones (*tale*) were slower than to nonhomophones (*pond*). Applying the same phonetic mediation model, they argued that the homophones were slower than nonhomophones because all items are initially recoded phonetically, but homophones run into difficulties at the spelling check stage. Since there is only one orthographically appropriate lexical entry for each item *(tale)* the orthographically inappropriate entry *(tail)* only delays recognition.

Although Clark (1973) has questioned the statistical reliability of Rubenstein et al.'s results, (1971), Meyer and Ruddy (1973) have replicated their experiment on the nonwords which sound like English words *(brane/brain)*. However, Meyer, Schvaneveldt, and Ruddy (1974a, b) and Ruddy, Meyer, and Schvaneveldt (1973) have pointed out that there is a confounding of the phonetic and graphemic information in the words used by Rubenstein et al. (1971). They argued that an item like *burd*, for example, not only sounds like an English word, but it also looks like one (*bird* shares three out of four letters with *burd)*. They argued that Rubenstein et al.'s homophony effects might be due to the graphemic rather than the phonetic similarity of their items.

Meyer et al. (1974a) investigated the relative contribution of phonetic and graphemic information in a slightly modified lexical decision task in which subjects were required to respond *yes* if two words were English, and otherwise to respond *no*. The critical comparisons were between pairs that were both graphemically and phonetically similar *(bribe/tribe, fence/hence)* and pairs that were just graphemically similar *(couch/touch, freak/break)*. If the subjects were using only graphemic information in their decisions, then the difference in reaction time between the pairs that are both phonetically and graphemically similar *(bribe/tribe, fence/hence)* and their corresponding phonetically and graphemically dissimilar control conditions *(bribe/hence, tribe/fence)* should equal the difference in reaction time between the pairs that are only graphemically similar *(couch/touch, freak/break)* and their corresponding phonetically and graphemically dissimilar control conditions (*couch/break, touch/freak*). On the other

hand, if phonetic information is being used to gain access to the internal lexicon, then a phonetic mismatch would occur in the graphemic condition (when the subject attempts to match *couch* and *touch* phonetically) producing a smaller difference between the graphemically similar pairs and their controls than between the phonetically and graphemically similar pairs and their controls. Meyer et al. (1974a) found that the word pairs in the graphemic condition were responded to more slowly than their corresponding control word pairs whereas the phonetically and graphemically similar word pairs were responded to slightly more rapidly than their corresponding control word pairs. These data suggest that subjects were recoding the words phonetically in the graphemic condition and were not basing their decisions upon the visual similarity of the words.

Although the experiment by Meyer et al. (1974) might be interpreted as indicating that phonetic recoding is an obligatory stage in lexical access, other interpretations are also possible. It is possible that the slight facilitation observed for the graphemically and phonetically similar words was due to the use of both graphemic and phonetic information in lexical access. In fact, Becker, Schvaneveldt, and Gomez (1973) used Meyer et al.'s (1974a, experiment 2) task and found greater facilitation (experimental-control difference) for pairs of words which were both graphemically and phonetically similar *(dime/time* versus *lean/time)* than for pairs of words which were only phonetically similar *(core/floor* versus *rose/floor).* In addition, Becker et al. (1973) were not able to replicate Meyer et al.'s (1974a) finding that word pairs which are graphemically, but not phonetically similar *(cough/touch)* have slower reaction times than their corresponding control word pairs *(couch/break).*

So far, the evidence for an obligatory phonetic stage in accessing the internal lexicon appears to be mixed; in fact, results by Meyer et al. (1974a) and Becker et al. (1973) can be interpreted as supporting a model in which access can take place on the basis of both phonetic and graphemic information. Similarly, Coltheart, Davelaar, Jonasson, and Besner (1977) and Forster and Chambers (1973) have argued for the involvement of both graphemic and phonetic information in lexical access. It is possible, however, that the

dual access interpretation of lexical access in word recognition may be limited to experiments carried out with the lexical decision task, which does not require processing at a semantic level. In order to evaluate more adequately the possibility that phonetic mediation is necessary to obtain access to word meanings, a task is needed which more closely approximates reading for meaning. Such a task is provided by Levy (1975). She required her subjects to read a set of three thematically related sentences which were followed by a test sentence. They were then required to decide whether the test sentence was one they had just read. Levy examined the role of phonetic mediation in reading for meaning by comparing her subject's performance when they read the sentences normally (silently) to when they read them while at the same time counting out loud. She found that their recognition accuracy was reduced dramatically by the requirement to both read silently and count out loud. These results suggest that the counting interfered with phonetic recoding during reading which, Levy argues, plays a role in maintaining words in memory for the purpose of sentence comprehension. Levy was also able to show that counting out loud did not disrupt listening comprehension as dramatically as reading comprehension which might be expected if counting out loud was a general type of interference which had nothing to do with phonetic mediation per se. Finally, Baron (1977) and Smith (1976) have obtained similar findings and have shown that motor interference tasks, such as tapping, do not interfere with reading to the same degree as tasks which require speaking.

In summary, although the results of the lexical decision experiments might be discounted because they do not require semantic processing, the experiments showing that counting out loud can interfere with an individual's attempts to recode sentences phonetically while reading for meaning would appear to indicate that a phonetic stage is necessary in order to obtain access to the meanings of printed words. It is also possible, however, that repeating digits out loud interferes with a phonetic memory coding strategy that may be necessary for sentence comprehension, but not necessary for accessing the meanings of single words (e.g., Levy, 1975). This possibility will be discussed later.

Evidence that Either Graphemic (Visual Pattern) or Phonetic Information Can Be Used to Access Meaning

Written language is, of course, represented visually so it is not entirely unreasonable to think that it might be processed on a visual basis. Logographic writing systems (Chinese, for example) may be processed visually without the necessity of phonetic mediation (Kolers, 1970). English, however, is alphabetic with an orthography whose primary characteristic is its relationship (though imperfect) to speech sounds rather than to meaning (see Gleitman and Rozin, 1977 for a thorough discussion of the relationships between orthographies and speech sounds). What, then, is the evidence that either visual pattern (graphemic) information or phonetic information is sufficient for obtaining access to the meanings of printed words?

Bower (1970) measured translation time for samples of foreign language text which were altered visually, but not phonetically, in order to demonstrate that it is possible to access meaning primarily on the basis of visual information. He noted that modern Greek has five graphemes which map to the English sound /ee/ and two graphemes which map to the English sound /o/ and he generated passages of text which were visually, but not phonetically, transformed by randomly substituting graphemes within the group of five /ee/s and interchanging the two graphemes for /o/. This transformation of text is a little like changing *physiology* to *fisiology* and *first* to *phirst* in English (Brown, 1970). If subjects normally use a phonetic strategy in order to gain access to lexical meaning, their translation times should not differ appreciably for the visually transformed and normal text because both types of text are phonetically equivalent. If, on the other hand, a visual strategy is used, then the subjects would be disrupted by the visually transformed text and they would be slower than on the normal text. In support of the visual strategy hypothesis, Bower (1970) found that subjects (four Greek-English bilinguals) translated more slowly and vocalized much more with the visually transformed than the normal text.

Unfortunately, however, Bower's experiment (1970) is convincing evidence for "reading by eye" only if, as Brown

points out, it is assumed that reading takes place letter by letter. If the reader utilizes units larger than a single letter (e.g., spelling patterns, syllables, vocalic center groups, morphemes, words) while reading, then the experiment provides little information one way or the other about how access to meaning takes place. In addition, the fact that subjects were slower on the visually transformed text can be interpreted as evidence for a phonetic rather than a visual strategy if it is assumed that obligatory phonetic recoding precedes a check of each word's spelling as in the Rubenstein, Lewis, and Rubenstein (1971) model of lexical access.

The apparent problems with the interpretation of Bower's experiment (1970) indicate that other experimental procedures are needed in order to find out if subjects can obtain direct access to lexical meaning on the basis of graphemic information. Baron (1973) carried out two experiments which provide much more convincing evidence for direct visual access to meaning. In his first experiment, Baron had subjects classify phrases on the basis of whether they "made sense" (respond *yes*) or "did not make sense" (respond *no*). The items requiring a *yes* response were *in the hall* and *nut and bolt* and the items requiring a *no* response were *in the haul* and *nut and bout*. If subjects habitually use phonetic mediation to gain access to lexical meaning, then they should be slower at responding *no* to items like *in the haul*, which sound but do not look like they make sense, than to items like *nut and bout* which neither sound nor look like they make sense. Although the subjects did not differ in response latency, they made more errors on phrases like *in the haul* than on phrases like *nut and bout*, suggesting that phonetic mediation may have been involved. A more direct test of the phonetic mediation hypothesis was made in his second experiment. The same four categories of phrases were used, but this time the subjects were required to respond *yes* if the phrase sounded like it made sense. Consequently, a *yes* response was appropriate for *in the haul* as well as for *in the hall* and *nut and bolt*. Baron (1973) found that subjects took longer and made more errors on phrases like *in the haul* than on phrases like *in the hall*. These results suggest that performance improves when subjects can use both visual and phonetic information to make their decisions. When they are required to use only phonetic information

(i.e., *in the haul),* they are slower and make more errors which should not happen if phonetic recoding is habitually applied (i.e., *in the haul* should equal *in the hall* in judgment time and errors).

Meyer and Ruddy (1973) have obtained additional evidence to support Baron's 1973 findings that lexical meaning access can take place on the basis of visual (graphemic) information in a task requiring a semantic decision. The subjects in Meyer and Ruddy's 1973 experiment were presented with a test question like *"is a kind of fruit"* followed a short time later with a test word *(pear)* which was used to interrogate their knowledge of category membership. Time to answer the question *(yes* or *no)* was recorded. Subjects received three types of items 1) members of the category *(pear);* 2) nonmembers of the category *(tail);* and 3) pseudomembers of the category which sounded like members, but looked like nonmembers *(pair).* Their experiment was similar to Baron's (1973) because both visual and sound criteria were used in classifying the items. In one part of their experiment, the items were classified according to a visual (graphemic) criteria (i.e., Is it spelled like, or does it look like, a category member?). Hence, a *yes* response was correct for *pear,* but not for *pair* or *tail.* In the other part of the experiment, the items were classified according to sound (phonetic) criteria (i.e., Is it pronounced like, or does it sound like, a category member?). In this case, *yes* responses were appropriate for both *pair* and *pear,* but a *no* response was still appropriate for *tail.*

The results obtained by Meyer and Ruddy (1973), like those of Baron (1973), appear to support the idea that both phonetic and graphemic access to lexical meaning can take place. In Meyer and Ruddy's visual task, it took subjects longer to decide that *pair* was not spelled like a fruit than to decide that *tail* was not spelled like a fruit. This finding supports the phonetic access hypothesis because, like Rubenstein, Lewis, and Rubenstein (1971), it suggests that an item like *pair* is initially recoded phonetically, but unlike *tail* it cannot be rejected as a nonmember of the category until the spelling of the item is checked. Also consistent with the phonetic access hypothesis, is the finding that subjects took longer to decide that *pear* was spelled like a fruit than to decide that it was pronounced like a fruit. Again, these results suggest that the

spelling is checked after the item is recoded phonetically.

The phonetic access hypothesis was not supported, however, by the finding that *tail* was rejected more rapidly because it was not spelled like a fruit (visual task) than because it was not pronounced like a fruit (sound task). The phonetic access model would predict equally fast rejection of *tail* in both tasks since *tail* can be rejected as a nonmember of the fruit category on a phonetic basis in both tasks. A graphemic access model, on the other hand, would predict that *tail* would be rejected more rapidly in the visual than the sound task because phonetic recoding requires an extra step. In addition, subjects took less time in the sound task to decide that *pear* was pronounced like a fruit than to decide that *pair* was pronounced like a fruit. Clearly, the phonetic model predicts equal latencies for both because their phonetic representations are identical. Consistent with the results of Baron's second experiment (1973), however, a graphemic access model would predict that *pear* would be faster than *pair*. An identical pattern of results was obtained by Meyer and Ruddy (1973) in a second experiment which employed a task very similar to one used by Collins and Quillian (1969). In this task, the subject was required to verify the truth or falsity of a sentence like *a pear is a kind of fruit* and the criteria for truth or falsity was based upon how the category instance looked *(pear)* or sounded *(pair)*.

Both Baron's and Meyer and Ruddy's 1973 experiments provide evidence indicating that phonetic mediation is not necessary in order to get to the meanings of printed words and that both visual and phonetic information are used. These experiments, however, do not offer much information about the extent to which subjects will rely upon visual rather than phonetic information to get to meaning when a choice can be made between these two types of information. In order to deal with this issue, Kleiman (1975) required subjects to make decisions about the phonetic, graphemic, and semantic similarity of pairs of words with and without the concurrent task of repeating digits out loud. In the phonetic similarity condition, a pair of words like *tickle/pickle* were given a *yes* response because they rhymed, whereas *lemon/demon* were given a *no* response because they did not. In the graphemic similarity condition, a pair of words like *heard/beard* were given a *yes* response because they are visually identical after the first letter, whereas *grace/price* were given a *no* response

because they differ in the third as well as the first letter position. In effect, the subjects were instructed to perform a visual letter search task in the graphemic condition. Finally, a word pair like *mourn/grieve* would be given a *yes* response in the semantic similarity condition, while *depart/couple* would be given a *no* response. Kleiman (1975) reasoned that if subjects were using a phonetic recoding strategy to obtain access to lexical meaning, then repeating digits out loud should increase the time to make their semantic similarity decisions about as much as the time to make their phonetic similarity decisions. The graphemic condition should increase much less because only visual information is used in making graphemic decisions. If, on the other hand, subjects chose to rely upon visual information to get to meaning, then the semantic and graphemic decisions should be increased by about the same amount when the subjects are required to repeat digits out loud, but this increase should be less than in the phonetic condition. Kleiman (1975) obtained evidence for direct visual access to meaning because the semantic and graphemic conditions increased 120 and 123 milliseconds respectively when the subjects were also required to repeat digits out loud. The phonetic condition, on the other hand, increased by 372 milliseconds. In order to make sure that subjects were using visual information in the graphemic task, Kleiman (1975) compared graphemically similar items which were also phonetically similar *(blame/flame)* to items which were not phonetically similar *(couch/touch)*. The decision time in these two conditions increased by about the same amount indicating that subjects were not using phonetic information to make their decisions even when they had the opportunity to do so. On the basis of these data, Kleiman (1975) was able to conclude that his subjects were, in fact, using visual information in the graphemic condition.

In summary, the results presented so far seem to indicate that phonetic mediation is not the only way to obtain access to the lexical meanings of printed words and that subjects do use both graphemic and phonetic information in getting to meaning (Baron, 1973; Meyer and Ruddy, 1973). In fact, the results indicate that direct visual access may be the preferred route to meaning when subjects are given a choice between the use of phonetic and graphemic information (Kleiman, 1975).

Evidence for the Roles of Phonetic and Graphemic Information in the Development of the Ability to Access the Meanings of Printed Words

Although evidence presented thus far seems to favor the conclusions that for fluent readers phonetic recoding is not necessary in order to get to the meanings of printed words, there is no reason to believe that this same conclusion would be drawn about children who are in the process of acquiring fluency in reading skill. There is indirect evidence to suggest that beginning readers find it necessary to use phonetic recoding to get to meaning. For example, a number of investigators (Calfee, Chapman, and Venezky, 1972; Chall, 1967; Firth, 1972; Gleitman and Rozin, 1977; Golinkoff, 1975, 1976; Liberman, Shankweiler, Liberman, Fowler and Fischer, 1977; Perfetti and Hogaboam, 1975) have argued that knowledge of "decoding skills" is an extremely important factor in learning to read fluently. Firth (1972) has shown that the ability to pronounce nonsense words correctly predicted poor and average reading ability with virtually 100 percent accuracy for a sample of eight-year-olds. He also found that the ability to pronounce nonsense words accounted for a very large percentage of the variance in the reading achievement of beginning readers (six-year-olds) when IQ was partialled out. Similarly, Perfetti and Hogaboam (1975) have shown that poor readers can be distinguished from good readers by the speed with which they can pronounce nonsense and low frequency printed words. Finally, Pace and Golinkoff (1976) recorded the speed with which good and poor readers could name pictures which had words superimposed upon them. Consistent with earlier studies (Golinkoff and Rosinski, 1976; Rosinski, Golinkoff, and Kukish, 1975), they found that the children were slower when the word and the picture were incongruent (e.g., the word *cat* printed on the picture of a pig) than when they were congruent (the word *cat* printed on the picture of a cat) suggesting that semantic interference may have been responsible for the slower response times in the incongruent condition. Pace and Golnikoff (1976), however, also found that their poor readers in the third grade showed less interference on those words which they found difficult to pronounce. Since

less interference may imply less semantic processing, they argued that decoding skill might be related to the ease with which children can access the meaning of printed words.

The aforementioned studies, which stress the importance of decoding skills in beginning reading, can be combined with the studies which show that fluent readers use visual information to go directly to meaning, and they can be used to formulate a developmental hypothesis about how children and adults obtain access to the meanings of printed words. The general form of this hypothesis might be stated as follows: Beginning readers start out by relying heavily upon phonetic information to obtain access to lexical meaning, but with schooling and practice in reading, they gradually become more skillful and begin to rely more heavily upon graphemic information to get to meaning. Although a developmental hypothesis of meaning access has been suggested by several investigators (Gibson and Levin, 1975; Rozin and Gleitman, 1977), Barron and Baron (1977) and Rader (1975) have tested it directly.

Rader (1975) required grade two, four, and six pupils and university students to decide whether pairs of words rhymed (*pie/buy*) or belonged to the same semantic category (*cat/dog*); these pairs of words were presented both visually and auditorily. She assumed that phonetic information must be used to decide whether two words rhyme, regardless of whether they are presented visually or auditorily, because graphemic similarity could not be used to make a rhyme decision in her experiment (the words did not share common spelling patterns, e.g., *pie/buy*). She also assumed that the auditory presentation condition provided a measure of the relative difficulty of the category and rhyme judgments (category judgments were more difficult, i.e., slower). Given these two assumptions, Rader hypothesized that, if phonetic access to meaning drops out with an increase in the children's ages, then there should be a greater decrease across age in the difference between the category and rhyme judgments under the visual than under the auditory presentation conditions. Rader reasoned that since the use of phonetic information is obligatory in the auditory condition, the category minus rhyme difference should not decrease as much across age in that condition.

Rader found that age had no effect upon the extent to which her subjects relied upon phonetic information to get to meaning because the category minus rhyme difference was consistently smaller with visual than with auditory presentation and relatively constant across all four age groups. Even her grade two children were able to use direct visual access to meaning because the difference between their category and rhyme tasks was less in the visual than the auditory condition for *yes* judgments. Therefore, Rader's results do not support a developmental hypothesis of meaning access.

Barron and Baron (1977) took a different approach to the possibility that there is a development change in the way in which children obtain access to word meanings. They required children in grades one, two, four, six, and eight to make meaning and phonetic (rhyme) similarity decisions about picture-word pairs. Consistent with the logic and procedures used by Levy (1975) and Kleiman (1975), they instructed their subjects to vocalize while making their decisions. Specifically, the children were required to repeat the words *double, double* out loud while making one-half of the rhyme and semantic similarity decisions. Barron and Baron (1977) argued that if children change during development from relying upon phonetic information to relying upon graphemic information to get to meaning, then vocalization should influence both the meaning and the rhyme task early in development, but only the sound task later in development, as the older children begin to use direct visual access. They found that vocalization increased the children's errors in the rhyme condition at each of the five grade levels, but that it had no influence upon decision times or errors for the meaning task at any of the grade levels, including grade 1. Barron and Baron's results are consistent with those obtained by Rader (1975) because they indicate that there is not a developmental change in the way that subjects obtain access to the meanings of printed words. Rather, their results indicate that even children who have had slightly less than a year of formal reading instruction are able to use graphemic information to go directly to the meanings of printed words.

Using Phonetic and Graphemic Information in Printed Words as Strategies for Extracting Meaning from Text

Taken together, the evidence presented so far indicates that phonetic information is not necessary to obtain access to the meanings of printed words, even for beginning readers. There is one important exception to this conclusion. The experiments by Baron (1977), Levy (1975), and Smith (1976) have all shown that requiring subjects to engage in vocalization while they are reading for meaning seriously interferes with the subject's ability to remember connected prose. These results are surprising in view of the fact that Baron, Levy, and Smith used the same interference task as Kleiman (1975) who concluded that phonetic recoding was not necessary to access single word meanings. The apparent discrepancy in results between the experiments involving single word access and the experiments involving connected prose appears to be related to differences in the memory demands involved in the two experimental situations. As aforementioned, Baron (1977), Levy (1975), and Smith (1976) have argued that reading connected prose places demands upon memory which are much greater than those involved in reading single words. They argued that reading connected prose requires the ability to retain the words of a sentence in active memory until the sentence message can be comprehended and that phonetic recoding is one of the most effective ways of retaining words in active memory.

Kleiman (1975), in fact, has carried out an experiment which provides evidence for phonetic recoding in a task requiring sentence comprehension and evidence for direct visual access to meaning in a similar task requiring the semantic categorization of a single word. He required his subjects to make four types of decisions (graphemic, phonetic, category, and semantic acceptability) with and without the concurrent task of repeating digits out loud. In the graphemic condition, the subjects were required to decide whether a target word *(bury)* looked like a word in a sentence (*Yesterday the grand jury adjourned);* in the phonetic condition, the subjects were required to decide whether a target word (*cream*) rhymed with a

word in a sentence (*He awakened from the dream);* and in the category condition, the subjects were required to decide whether a target word (*games*) named a semantic category of which a word in a sentence was a member (*Everyone at home played monopoly).* Finally, subjects were required to decide whether a sentence "made sense" in the semantic acceptability condition (*Noisy parties disturb sleeping neighbors* versus *Pizzas have been eating Jerry*). Consistent with the results of his previous experiments, Kleiman (1975) found that vocalization increased the time for the graphemic (140 milliseconds) and category (78 milliseconds) decisions by about the same amount, but that this increase was less than the increase in the time for the phonetic decisions (312 milliseconds). Given the logic of Kleiman's earlier experiment, these results indicate that phonetic recoding is not necessary in order to decide about the semantic category membership of individual printed words. Kleiman also found, however, that subvocalization increased the time to make semantic acceptability decisions (394 milliseconds) about as much as it increased the time to make the phonetic decisions. These latter findings appear to implicate phonetic recoding in sentence comprehension.

It does not appear, therefore, that there is any real conflict over the fact that both beginning and skilled readers can use graphemic information to access directly word meanings and the fact that vocalization interferes with reading connected prose. Apparently, the demands upon memory are so great when reading connected prose that phonetic recoding is often necessary in order to avoid a failure in comprehension. Reading single words, on the other hand, probably places minimal demands upon memory (unless, perhaps, the word is unfamiliar) and allows the individual to use graphemic information to get to meaning. Accordingly, it might be worthwhile to regard phonetic recoding as a strategy, rather than as an obligatory procedure, which is used when the reading situation places demands upon memory. Similarly, direct visual access to meaning might also be regarded as a strategy which is used when speed of processing is important, familiarity with the materials is high, and memory demands are low.

Conclusions and Implications

Considerable evidence has been presented to support the argument that both graphemic and phonetic information can be used to obtain access to the meanings of printed words and that these alternative routes to meaning can be regarded as strategies which are under the control of the individual. There are several implications of these conclusions. The first is that it is possible that one of the reasons phonics knowledge (decoding skill) correlates so highly with success in learning to read (Firth, 1972) is that good decoders are individuals who can rapidly and accurately convert printed words into phonetic representations which can be maintained in memory (Liberman, Shankweiller, Liberman, Fowler, and Fischer, 1977). In fact, Perfetti (1977) and Perfetti and Lesgold (in press) have argued that much of the individual variation in reading comprehension ability has its origins in differences in the speed and accuracy with which individuals can decode words into their phonetic representations, rather than in differences in short-term memory capacity per se.

A second implication of the idea that there are multiple strategies for accessing word meanings is that visual information can be used to get to meaning. Unfortunately, not much is known about the nature of this visual information nor how it is learned and used to obtain access to meaning. It is known, however, that knowledge of spelling-to-sound correspondence rules are helpful in achieving fluency in word recognition even when the words are made up of letters from an artificial alphabet (Baron, 1977; Brooks, 1977). It is also known that there are individual differences among fluent adult readers in the extent to which they know and rely upon spelling-to-sound correspondence rules in pronouncing printed words (Baron and Strawson, 1976). What is not known is how knowledge of spelling-to-sound correspondences actually assists in the acquisition and performance of visual word recognition skills. Does knowledge of spelling-to-sound correspondence rules help children learn to read by providing another way of specifying the redundant spatial and sequential information in printed word patterns (spelling patterns, Gibson and Levin, 1975)

which may be important for meaning access? Certainly, the difficulty that the deaf experience in learning to read offers indirect support for the importance of having an intermodal specification of the information in printed words (Gibson, Shurcliff, and Yonas, 1970). It is also possible that sound correlated processing is primarily post lexical (C. Chomsky, 1970; N. Chomsky, 1970; Chambers and Forster, 1973) and that, as aforementioned, knowledge of spelling-to-sound correspondence rules are primarily important in providing a mechanism for learning new words and for coding words in memory, rather than for obtaining access to meaning. Obviously, these are problems for future research.

Finally, given the notion that there are alternative strategies for obtaining access to the meanings of printed words, it might be worthwhile to consider fluent readers as individuals who not only possess considerable skill in the graphemic and phonetic analysis of words, but who also know how to apply this knowledge most efficiently for the purpose of extracting from text the information most relevant to their purposes and background knowledge. Reading an article about a familiar topic in a newspaper, for example, may require much less phonetic recoding than reading about an unfamiliar topic in a textbook. It could be argued, therefore, that learning to read fluently may involve much more than acquiring certain basic skills (the ability to pronounce words accurately and rapidly). It may also involve the development of self-knowledge and awareness of when and how to apply these basic skills for the purpose of extracting meaning from print (Brown and Smiley, 1977; Forrest and Barron, 1977).

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Wh* N**ds V*w*ls?

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The typical American child of school age displays remarkable implicit knowledge of the sound regularities of English. The chances are good that he also has a finer ear for distinguishing among similar speech sounds than his reading teacher. Unfortunately, these are but small blessings in learning to read. In a vast conspiracy, history has mined the child's road to literacy with hundreds of exceptions and minor rules. Nevertheless, as the title of this chapter shows, there is hope for our small hero. Most of the peculiarities of English spelling are confined to its system of representing vowels. To be sure, vowels often distinguish among words. No one would claim that vowels merely fill the silences between the consonants. But how would you have read the title had it been spelled "**o *ee** *o*e**?"

The example of the title (for which I am indebted to linguist Roger Shuy) suggests that at least fluent adult readers can fill the spaces between the consonants almost as well as our English spelling system does. In fact, Hebrew spelling is based on this very principle. The ability of even an English reader to identify words without vowels can be explained if he characteristically consults his knowledge of the sounds or pronunciations of words as he reads. This is an intuitively satisfying conception of the word recognition process, yet it is not universally accepted. Several theorists maintain that, among adults, reading happens too fast for the reader to hear the sound of the word in the mind's ear or to covertly pronounce each word in order to recognize it or recall its meaning. If the reader indeed consults his phonological knowledge, according to these theorists, this knowledge must be of a highly abstract nature—only distantly related to talking and listening. An understanding of the reading process therefore requires a description of the unconscious knowledge which the reader has of the speech sounds of his language.

Underlying Forms

As psycholinguist Dan I. Slobin once described reading, we don't look at words--we look through then. What we feel we see is not strings of letters, but rather members of categories which we recognize as familiar, meaningful words. Similarly, a toddler will recognize a certain word when spoken by a man, a woman, or another child, despite the highly distinct acoustical manifestations of each. In both the adult and the young child, in both reading and listening, a particular word token seems to stimulate a unique word type, a unique category label or word address.

To describe that unique underlying form of a word is to describe our phonological knowledge. The phonology of English, for example, can be represented as a list of rules which predict how each speech sound will be affected by its neighboring sounds. Not all possible sounds occur in every human language, nor do all possible sequences of permitted sounds occur within a given language. If the reader has access to this knowledge, it would aid him by limiting the number of alternatives from which he must choose in identifying a word. If our phonological knowledge is limited to a knowledge of how we move our articulators to produce desired sounds, then we would best describe underlying word forms in the concrete units of articulation and audition. On the other hand, if all the regularities of the sound pattern of English are truly contained in our linguistic competence, then underlying forms must be abstract indeed. Chomsky and Halle (1968), after surveying the many regularities of the English sound system concluded that underlying forms are highly abstract. In contrast Stampe (1968) has studied the child speech development and concluded that underlying forms are concrete and probably auditory. Not incidentally the two theories lead to contradictory predictions about the psychological reality or "reasonableness" of the English spelling system.

Abstract Phonological Knowledge

In *The Sound Pattern of English*, Chomsky and Halle (1968) express the view that all the phonological regularities in a language reflect the implicit knowledge of its speakers.

Phonological rules are valued according to the wideness of their applicability. Often the scope of a phonological rule may be extended by modifying a proposed underlying form. The authors place relatively few restrictions on the nature of phonological rules or on the description of underlying forms, and so often postulate highly abstract underlying forms. Chomsky and Halle believe the phonologist has succeeded in capturing the native speaker's intuitive, implicit knowledge when his phonological theory is composed of a small number of highly general rules and also a minimal number of underlying forms.

As a common example of phonological knowledge, Chomsky (1964) cites our knowledge of permissable monosyllables. The English dictionary has an entry for *pick* but not for *blick* or *ftick*. Any speaker of English knows, however, that *blick* could become a word, but *ftick* could not. Although not English, *ftick* can be pronounced and could conceivably be a word in another language. Therefore, at least some phonological knowledge must be part of the native speaker's competence which he uses to exclude pronounceable but nevertheless "illegal" words. Similarly, consonant alternations like *ethnic-ethnicity* or *medic-medicine* occur in the language, yet are not conditioned by the anatomy of the articulators; one can easily pronounce *medikine* or *ethnikity*. Chomsky and Halle claim that the above consonant alternation actually describes an adult's implicit knowledge of his language. The authors would believe that *medic* and *medicine* have a common underlying form as well as a common etymological history. One of Chomsky and Halle's most controversial claims is that the vowel alternations in pairs like *divine-divinity, extreme-extremity, verbose-verbosity*,etc, may all be described by just two (admittedly complicated) rules which form a part of every native English speaker's implicit understanding of his language.

Chomsky and Halle note in passing that the underlying forms they postulate for English words are quite similar to their English spellings, and that orthography may represent a psychologically real level of understanding of an English speaker's knowledge of his language:

> The fundamental principle of orthography is that phonetic variation is not indicated where it is predictable by general

> rule....It is therefore noteworthy, but not surprising, that English orthography, despite its often cited inconsistencies, comes remarkably close to being an optimal system for English. Correspondingly, it would not be surprising to discover that an adequate theory of production and perception of speech will find a place for a system of representation not unlike orthography (p. 49).

This paragraph implies that the recognition of a printed English word by a native speaker can proceed with maximum efficiency. The English reader might map English spellings directly onto his underlying phonological forms without help (or distraction) from speech images or gestures.

Psycholinguist Philip Gough (1972) believes mature readers read much too fast to "go through the speech loop," and suggests that readers map letters not onto sounds, but rather onto their corresponding units in abstract underlying forms, the systematic phonemes:

> it seems reasonable to assume that the speaker of a language employs, in the comprehension of speech, retrieval mechanisms that access lexical entries through these lexical representations. If characters are converted into comparable representations, then available retrieval mechanisms could be engaged, and searching for meaning in reading would require no costly new apparatus (p.337).

Apparently Gough assumes that there is an instant in spontaneous speech between the intention to say a particular word and the "posting of the motor commands." During that instant the word is represented as a series of abstract entities which are related to the movements of the articulators "only by means of a complex series of phonological rules." Since, if Chomsky and Halle are correct, the orthography also does not explicitly represent sound alternations describable by phonological rule, Gough feels justified in suggesting that the mapping of letters onto systematic phonemes might actually occur in mature reading.

Some Doubts about Highly Abstract Underlying Forms

Gough acknowledges Conrad's review (1972) of the evidence that visual information is spontaneously recoded into acoustic images, but believes that the eye movements in silent reading occur too frequently to allow generation of a full phonetic image. Since underlying forms composed of system-

atic phonemes have a one-to-one correspondence with pronounceable words, yet they themselves are not pronounced, they fit nicely into Gough's hypothesis. However, both the nonpronounceability of underlying linguistic forms and the impossibility of full phonetic representations occurring in reading are open to question. For one thing, the spoken durations of words do not affect reading rate when the words occur in connected text (Feldman, 1975). Furthermore, a number of investigators have found that an increase in reading rate is accompanied by an increase in electromyographically detectable speech muscle activity (McGuigan and Pinkney, 1973; Feldman, 1975.)

The few experimental tests of the Chomsky-Halle vowel shift rule have given little evidence of its productivity. Though the rule describes predictable variations in the pronunciations of vowels which are ignored by the orthography, experimental subjects almost never spontaneously apply the rules to novel words (Steinberg, 1973). In contrast, children spontaneously apply rules which are conditioned by the mechanics of the vocal tract (Berko, 1958).

Children learning English would be unlikely to encounter the exemplars from which Chomsky and Halle deduced their vowel shift rule. The Romance vocabulary which displays the shift is among the most erudite in the language, and the number of words which have alternate vowel pronunciations—or even the number of verbs which take the *-ity* suffix—is small relative to the number of words which do not. Furthermore, the inclusion of back vowels in the vowel shift rule results in the necessity of several more fix-up rules to account for apparent exceptions. Finally, there are historically unrelated words which seem to be related by the vowel shift rule, yet are etymologically unrelated, such as *comply-complicity, admire-admiral,* and *mate-mattress.* Detection of the rule governed alternations by the language learner would probably also be complicated by other vowel alternations which do not follow the pervasive pattern, such as retain-retention (compare to sane-sanity), as well as other words which entered the language after the vowel shift or for some reason do not undergo the vowel shift (obese-obesity). From the above evidence, Moskowitz (1973) argues that the vowel shift rule is probably not a description of the linguistic competence of

native speakers.

Language-specific phonological knowledge such as vowel alternation is not necessary for learning to read. In fact if such knowledge is ever acquired, it probably comes from exposure to formal, academic writing. The admittedly limited empirical evidence points away from abstract underlying forms and towards concrete, phonetically underlying forms. The child's phonological knowledge at the age of beginning reading instruction is probably better described by natural phonology than by an abstract generative phonology such as Chomsky and Halle proposed.

Concrete Underlying Forms and Natural Phonology

Considerations from Phonological Development

Ferguson and Garnica (in press) have written a brief and useful review of developmental models of phonology. The authors require that any comprehensive theory of developmental phonology address some common questions. For one, of all the sounds the human vocal apparatus can produce, how does the child learn which distinguish between words in his language? A segment is voiced if the vocal folds are brought together and allowed to vibrate during the articulation of the segment. The vocal folds vibrate during or immediately after the initial closure of the lips in *big*, but vibration is delayed several milliseconds after the closure in *pig*. The child learns that *big* and *pig* and other words in the language are distinguished by the voicing of the consonants. The child apparently also learns, however, that the voicing of a segment does not always affect meaning. A model of developmental phonology must also address the question of how the child learns non-distinctive alternations. The "l" sound in English is usually voiced, but occasionally is unvoiced when following a voiceless stop, as in *play*, where the "l" voice feature assumes the voicing of the preceding segment. How does a child come to know that a feature which is distinctive in one context is not distinctive in another? Although it is possible that meaning changing errors in a child's pronunciations may be corrected by adults, adults certainly do not teach children the non-distinctive alternations, such as between voiced and voiceless "l."

Besides accounting for the child's acquisition of the adult sound system, the adequate model of developmental phonology must also account for the child's deviations along the way. In a well-known diary study of language acquisition, Leopold (1947) noted that his daughter abandoned her correct or adult-like pronunciation of *pretty* for one without the "r" sound, which at the time did not occur elsewhere in her speech. A developmental model which required reinforcement to direct development could not explain how a correct and presumably rewarded pronunciation could be supplanted by an incorrect pronunciation. Furthermore, merely being able to produce that segment in one context does not mean the child will be able to produce that segment in all other contexts. A two- or three-year-old may mispronounce "juice" as "deuce," yet will use the /j/ sound—incorrectly—as the initial segment of "choo-choo" or "church" (Leopold, 1947).

Thus the child's deviations from the adult norm cannot be accounted for simply as a motor deficit, but may be also related to the child's conception of the underlying forms of his language and to the rules which realize the underlying forms. Stampe (1972) believes the same phenomena can be seen in adult speech. An American adult will often pronounce the medial stop in "Betty," especially in casual speech, as a ballistic movement of the tongue against the alveolar ridge. The Britisher will pronounce the sound represented by *r* in *berry* as a similar alveolar flap. The American, however, will experience great difficulty in "pronouncing *berry* like a Britisher." The articulatory movements for the American *Betty* and the British *berry* are similar enough to be interchangeable—but the American is accustomed to allowing the flap rule to apply only to underlying /t/ or /d/, and not to underlying /r/. To do so would be unnatural (or, at least, un-American).

Finally, a model of developmental phonology must account for what Berko and Brown (1960) call the *fis* phenomenon, the ability of children to hear phonetic distinctions which they cannot produce. The authors describe an exchange between a child and an adult, in which the child clearly said "fis," but would only accept "fish" as a proper imitation of his utterance. The child gave no indication that he was aware that there was anything deviant about his own

pronunciation. Shvachkin (1948), similarly, was able to teach approximately one- to two-year-old children to distinguish all the consonants and vowel oppositions of Russian long before the children could produce the sounds. Menyuk and Anderson (1969) discovered that children are less consistent than adults in perceiving the distinctions among /w/, /r/, and /l/, but can distinguish among these sounds more reliably than they can produce them. Any theory of speech perception which requires that the listener match sounds to his own articulations will have a difficult time accounting for this production-perception discrepancy in children.

Natural Phonology

Chomsky and Halle (1968) are well aware that their model of phonology describes alternations in the English sound pattern which the child has not yet encountered. The child could hardly have interiorized the consonant alternation in "medic-medicinal" or the vowel alternation in "verbose-verbosity." The alternations which children do seem to acquire, according to Stampe (1972), are those that are motivated by the physical constraints of the speech apparatus. In Stampe's Natural Phonology, the phonological rules which describe the regularities in adult speech are a residue of the natural rules which every prelinguistic child brings to language learning. When natural processes conflict, the child is led to discover the particular sound differences which distinguish words in his language. Considering voicing again, there is a natural tendency for stops to be unvoiced. If you hold your nose and pronounce /m/, the reason for this soon becomes apparent. To make the vocal folds vibrate, there must be a lower pressure above them than below. If the airstream is blocked, as it is during production of a stop consonant, the duration of the voicing is limited by the capacity of the oral cavity to expand and lower the post-glottal pressure. The voicing duration can be slightly extended if the larynx is lowered (resulting, incidentally, in a drop in pitch). Of course, an unvoiced stop can be held indefinitely. Conversely there is also a tendency for stops to be voiced when they occur between vowels. Both the intrinsic devoicing of stops and the voicing assimilation of intervocalic stops are commonly observed in

children's early productions. However, the child must learn to limit or suppress these natural processes, since voicing of stops distinguishes between words in English and is therefore not predictable from phonetic context. The child also typically avoids consonant clusters; his productions usually follow an alternating consonant vowel pattern like CV, CVC, CVCV, and so forth (such as *cat, dog, mommy*). A child learning Japanese need seldom deviate from this consonant-vowel pattern by limiting the natural rule of consonant cluster reduction. English, in contrast, allows many consonant clusters, and so the English speaking child must overcome a natural avoidance of coarticulations.

Some natural processes which occur in children's speech are not suppressed, but occur in adult speech as well. Like adults, children lengthen vowels before voiced consonants, including in situations in which underlying voiced consonants are not voiced in actual speech. Vowel length distinguishes between "writer" and "rider" in the speech of adults who render intervocalic aleolar stops as flaps. Like many of the children in developmental phonology literature, Velten's daughter (1943) Joan consistently devoiced word final stops. Thus both *bead* and *beat* for Joan ended with the same voiceless stop, yet *bead* was pronounced with a longer vowel than *beat*. It is not enough to attribute vocal lengthening before voiced stops to the additional time necessary to lower the larynx for the voiced stop. One might be tempted to argue that natural phonological rules need not represent the linguistic knowledge of the speaker—that is, are not internalized in any way—because they seem to be conditioned by the inertia of the articulators. Yet the *bead-beat* vowel length alternation shows that the rules are applied even in the absence of actual articulatory gestures. Also, as Stampe observes, if one merely recalls the sounds of the words *bead* and *beat* silently, the resulting auditory image seems longer for *bead* than for *beat*.

Unlike the abstract underlying representation of the Chomsky-Halle model, which presumes the speaker's knowledge of the phonological rules of the language, the concrete underlying representation in Stampe's model is a phonetically-based target which the child hypothesizes from listening to examples of adult speech. Although this hypothesizing process

is mysterious, it cannot be difficult. My dog does it. She reacts appropriately to "cookie," "walk," and "bed" no matter who says them. Stampe's theory does not place the burden of perception on production, but in fact even predicts that perception precedes production.

Note that Stampe's theory provides no mechanism for "acquiring" rules, but only for limiting the application of natural rules. This is tantamount to claiming that the structural regularities, such as those described by the vowel shift rule, which do not occur spontaneously in young children's speech are qualitatively different from those that do.

The implication of Stampe's theory is that the hypothesized underlying representation is closer to the adult's production than to the child's. While the Chomsky-Halle formulation suggests that learning the phonology of one's language consists of noticing more and more rules and increasing the abstractness of the underlying form (and the psychological distance between the underlying form and the surface manifestation), Stampe's formulation portrays the acquisition of the phonological systems as the decrease in the distance between the target underlying form and surface manifestation. Chomsky and Halle propose a divergence of underlying form and pronunciation; Stampe proposes a convergence, a fine-tuning of a muscular act to the peculiarities of one's native language.

Reading

The child of reading instruction age seems to have concrete, adult-like conceptions of the sounds of words. Since the children's perceptions of words are more precise than their productions, the underlying forms are probably acoustic rather than motoric. Although the child's productions may not match the adult's productions, the child's underlying form, or acoustic hypothesis, may well be identical to the adult's. Furthermore, both the child's and the adult's underlying forms seem more concrete than the morphophonemic level represented in the orthography. English orthography captures regularities in the sound system of which even the literate adult is unaware.

A developmental theory which requires the continual revision of underlying lexical forms loses the advantages

gained by postulating underlying forms in the first place. If underlying forms represent a physiologically real level of representation prior to the posting of motor commands (or during reading), and if the command programs are continually changing during development, then the child's task of recognizing manifestations of labels in text or speech becomes one of hitting a moving target. If the target is stationary acoustically based hypothesis gleaned from adult speech, then correct, adult-like pronunciation should not be required for matching stimuli to labels. As the *fis* phenomenon suggests, children may well be unaware of their own deviations in speech from adult norms. Between its intention and its production, the word passes through the child's idiosyncratic phonological system. As the child gains mastery over the many muscles involved in speech production, the overt articulatory acts stabilize, and the child's production approximates his own acoustically based underlying form. This conception of underlying forms predicts that articulatory deficits should not affect silent reading comprehension, and the literature generally confirms this prediction (Rubin, Lyle and Balow). Once speech motor commands are stabilized in the reader, they may prove a reliable additional route to meaning. Whether the reader can bypass the acoustic image label completely is an empirical question. The congenitally deaf can learn American Sign Language as a native language, implying that their underlying forms would be abstracted visual images. But can a hearing adult learn to send and receive sign without interference from acoustic images? How successful are normal adults at inhibiting or ignoring the highly overlearned, automatic associations between text and sound? Gibson, Shurcliff, and Yonas (1970) found that deaf subjects were apparently sensitive to the spelling patterns of English, but this finding alone is insufficient for surmising that hearing subjects would be able to use spelling patterns at the exclusion of acoustic images for accessing meaning.

A discussion of the development of underlying forms in reading eventually must consider the possibility that the experienced reader has arrived at underlying visual forms which can serve as labels. This occurs to some extent, as can be seen from the confusion encountered in reading homophonic text like "the haul closet" or "the bear facts." Such examples

may only show that direct vision to meaning links occur in addition to, and not instead of, visual to acoustic to meaning links in mature reading. Similarly, the much hera'ded fidelity of orthography to morphemic representation may only reinforce rather than supplant, the essentially acoustic or articulatory processing in the mature reader.

Summary and Conclusion

Print and speech are physical manifestations of the same underlying linguistic forms, or arbitrary labels paired with meanings. Phonological rules describe the relationship between the underlying forms and the surface phonetic representations. According to Chomsky and Halle, phonological development is complete only when the speaker has internalized all of the phonological regularities of his language, and his underlying forms have become maximally abstract. According to Stampe, phonological development occurs as the child learns which of the universal physiologically determined phonological rules must be limited or suppressed in order to produce all the sound distinctions required in one's native language. Stampe's underlying forms are concrete, acoustically based hypotheses which the child draws from the speech of more experienced speakers. Language specific regularities unrelated to the physiology of the vocal tract are probably irrelevant to the production and perception of speech.

In spite of its many inconsistencies, English orthography has been claimed by some linguists to be a near optimal writing system for English because it often ignores predictable sound differences between semantically related words. Gough, for one, believes that reading in adults may include a simple mapping of letters onto the systematic phonemes of highly abstract underlying forms. There is as yet, however, little empirical evidence that language specific, non-physiologically motivated regularities are a productive part of linguistic competence, and that the level at which the language user pairs labels with concepts is as abstract as Gough requires. Although written symbols may also come to serve as labels, they are likely accompanied by highly familiar, difficult-to-suppress auditory images.

A survey of the literature on phonological development

reveals little evidence for a good fit between English spellings and underlying forms accessed during reading or listening. Correspondingly, it would not be surprising to find that an adequate theory of English reading will lean heavily on syntactic, semantic, and pragmatic constraints, and leave abstract phonological knowledge to the linguists. Anyway, wh* n**ds v*w*ls?

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